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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Hard White Spots in Iron Castings.

It is probable that defective castings caused by the appearance of what we have previously termed internal chill are more frequent than is generally believed. We are not aware that British foundry experts are at all agreed as to its cause, but Continental researches seem to indicate that liquidation set up by internal pressure is the actual cause. A typical case has been dealt with in Stahl und Eilsen by Mr. B. Osann, who took as an example the runner from a large sheetmill roll. The roll was made of fairly hard iron, and was cast in lined chill. The 4-in. runner, on breaking, exhibited a fracture, which was characterised by the existence, next to the skin, of a white ring, enclosing a grey centre, containing white regions, which, however, were not so clearly defined as the ring.

The metal was melted in a reverberatory furnace, and, owing to a delay, it was subjected to a certan amount of refining, resulting in the formation of a frothy slag. On being turned, the roll itself was found to be studded with hard spots and white areas in sufficient quantities to cause it to be scrapped.

Two samples on the runner in question by drilling it right through diametrically, after having detached the sandy skin, which was hard and firmly adhering. The outside layer was composed of sand and fine granules of iron, which fettling had failed to remove. The analysis of the various portions are shown in the following table:—

Portion.	Tot C	Gr.	C.C.	Si.	Mn.	P.	S.
Average Runner	2.45	1.55	0.90	0.79	0.81	0.26	0.099
White Ring ..	1.36	0.26	1.10	0.75	0.68	0.15	0.055
Grey Interior ..	2.61	1.70	0.91	0.78	0.82	0.27	0.104
Skin	3.72	—	—	10.09	0.37	0.33	0.091
Metallic Grains in Skin ..	3.00	—	—	0.80	0.30	0.26	0.07

It is interesting to note that both in the white ring and the grey interior 0.26 per cent. copper was found. A point which should not be lost sight of is the amount of carbon shown, both in the skin and the magnetically-separated granules. Even if the sand had contained organic matter, the nature of the operations preclude any hypothesis based on cementation. The probable explanation is that as there exists between the white ring and the grey interior a marked difference in carbon content, due to an expulsion through the solidified external layer of liquid alloy, consisting of a highly-carburised eutectic, which has set up an exodus of carbon to the exterior of the casting, leaving a crystalline skeleton low in carbon.

It should be borne in mind, says Osann, that the walls of the runner, having been strongly heated, is later distinctly hotter than the iron which fills it, and the conditions may be that the interior of the runner was already solidified, whilst the outside zone was still composed of a crystalline structure, of which the interstices were filled with liquid eutectic. This liquid portion finally was pushed outside by internal pressure due to the combined effects of the expansion of the liquid iron from the solidification of its external film with outside to inside contraction. Such internal pressure can cause the level of liquid iron to rise in a runner, or if this is already frozen it will show itself somewhere on the surface. In this particular case, this pressure must have been very high, because of the important contraction, perhaps due to the evolution of gas at the moment of the formation of the crystals. The iron leaving this defective runner would be expected to contain large quantities of ferrous oxide, and, consequently, to have resulted in a gas evolution of marked importance. Obviously, extraordinary results are to be anticipated from so abnormal a carbon content as 2.4 per cent. In his micrographic examination, Osann found that in the grey centre, graphite particles were present in a matrix of pearlite, associated with some small, clearly-defined crystals of sulphides. The white ring was composed of cementite embedded in pearlite, and dark spots, which were possibly graphite, but probably cavities associated with the expulsion of the eutectic. If analysis had shown 0.50 per cent. of graphite in conjunction with 0.90 per cent. of combined carbon, then with such conditions the iron with only 1.4 per cent. of carbon can give rise to a separation of graphite, it can safely be presumed that this separation is prior to the expulsion of the still liquid mass.

The skin, on examination, showed that at the side of holes of dark tint, the presence of sand

areas and iron granules. These latter appeared to consist of a cementite structure with pearlite interposed. It could be seen that these were grains of iron expelled from the casting in the form of drops, which in no way could consist of crystals. These eutectic grains contained 3 per cent. carbon, but if pure iron carbon alloys were to be experimented with, this content should be 4.2 per cent. (ledeburite).

The dull white internal spots resemble chilled iron, and the certainly produced by a perturbation of the separation of the graphite.

Briefly, the phenomena outlined are due to a low carbon and a high ferrous oxide content, associated with a high gas content in the metal. The reverberbatory furnace had acted as a puddling furnace. As to the 0.28 per cent. phosphorus, that should only constitute a connected problem.

The presence of hard spots on the roll admits of the same explanation as the runner; a white crust is formed on its circumference after the expulsion of the eutectic alloy, and this expulsion takes place at the points where the solidified crust is thinnest. The contraction creating a void between the mould face and the casting, it will be readily understood that the shell will oppose the expulsion only so far as it can. Mr. Osann concludes by stating that the practical observations to be made are that a slow-melting reverbatory furnace is to be avoided, but should similar conditions arrive, additions should be made of high manganese pig-iron, and probably ferro-silicon, to deoxidise the metal.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Chromium Irons and Steels.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—We have read your note on ferro-chromium and stainless iron appearing in your issue of the 24 inst., and while not being desirous of expressing any views upon the ideas you put forward for removing the scale from the surface of castings containing high percentages of chromium, we must emphatically deny your statement to the effect that it is impossible to cast chromium stainless iron.

We can say, from practical experience obtained by ourselves and friends interested in the matter, that there is apparently no good reason why satisfactory castings should not be regularly produced in stainless iron or stainless steel, with due observance to the practical problems involved.

We have made, under primitive conditions, both medium size and small castings which have turned out excellently, and consider that the near future will show great developments in this direction.—Yours, etc.,

SANSTAIN, LIMITED,
W. L. TURNER,
Director.

The Albany, Liverpool.
November 30.

[When we said it was impossible to make castings direct from stainless iron, this was undoubtedly a *lapsus calami*. What we should have said was that it was extremely difficult. The difficulties were, in our opinion, sufficiently great as to preclude its adoption as a commercial process. As is well known, when high chromium ferrous alloys are cast, there is thrown to the outside of the stream what is known to the Sheffield trades as "crud." This "crud" is generally supposed to be oxide of chromium, and there is every reason to believe that it would cause endless sand, surface and running difficulties. If Messrs. Sanstan, Ltd., have overcome these difficulties they are to be congratulated. In spite of this, we are still of opinion that experiments conducted for the purpose of ascertaining whether material of the composition of stainless iron could not be obtained on the surface of castings by subjecting suitable high-carbon iron-chromium alloys to a suitable malleablising process are worth while.—Editor.]

Endurance Testing Machines.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I am much interested in the article by Mr. Shapira in your issue of December 1 on fatigue-testing machines, and note the German modification of the Stanton machine similar to the Eden-Foster as made in this country. I was not a little surprised to find that the author had included under this heading the unique machine made by my principals, Messrs. Alfred J. Amsler & Company, of Schaffhouse, for determining the abrasion properties of metals, which is slightly different from the "wear and tear."

If he had desired to describe strictly comparative machines of Messrs. Amsler's make, it would, I believe, have been preferable to give details either of their Wöhler form of rotary bending machine for two specimens, or, better still, their compact quadruple hammer machine for making fatigue tests by means of repeated impact. This machine is perfectly automatic and self-registering, and to suit various conveniences, it can be provided with only two pairs or one pair of hammers. This machine was first described in this country in a Paper read before the South Staffordshire Iron and Steel Institute in 1918, *vide* their proceedings, as was also the more specialised abrasion testing machine now mentioned by your contributor. My chief reason for enclosing you a fuller description is to point out several little matters which have been brought before me by correspondents who have apparently read your article. In the first place the machine does not apply a "shocking stress" to the two specimens, but an eccentric can be put into action when desired, and thus cause an occasional release of the load on the test pieces in such a way as to closely represent the rolling of a locomotive wheel upon the rail. During the whole of the test one of the test pieces is made to move to and fro axially so as to distribute suitably the wear or abrasion over the full width of the discs and thus avoid seizing. The measurement of the amount of work done in rotating the lower of the two test discs is made by the cumulative roller which moves along a radius of the plate revolving at a proportional speer. The radial displacement is controlled by the pendulum dynamometer, which in turn is measuring the torque, so that the counter gives the product of these two, and therefore a measure of the total work.

Yours, etc., T. J. PRIMROSE.

Forthcoming Events.

Institution of British Foundrymen.

Sheffield Branch.—"Fluidity of Molten Metals," by Prof C. H. Desch, on December 19.
East Midland Branch.—"Foundry Facings," by H. Winterton, on January 21, 1922, at Loughborough.
Coventry Branch.—"Foundry Training," by T. Vickers, on January 11, 1922.

Sheffield Association of Metallurgists and Metallurgical Chemists.

"Corrosion of Metals," by R. Rogers, on December 13.
"The Effect of Solders on Beta Brasses," by J. H. S. Dickenson, on December 20.

Institute of Metals.

Sheffield Section.—"Electric Furnaces," by A. G. Lobley, on December 16.
Scottish Section.—"White Metals," by G. E. Fleming, on December 13.

Institute of Mechanical Engineers.

Annual dinner on December 15.

Staffordshire Iron and Steel Institute.

"Cast Iron for Foundry Purposes," by F. S. Wilkinson, on December 17.

London Section of the Society of Chemical Industry and the Chemical Industry Club.

Projection of Kinematograph Films showing Manufacture of Steel by the Crucible, Open-hearth, Electric, and Bessemer Processes, on December 13.

Institute of Marine Engineers.

"The Problem of Grey Iron Castings," by H. J. Young, on December 13

A RESEARCH of the heat treatment of non-ferrous castings is to be made by the United States Bureau of Mines at the Pittsburgh, Pa., Experiment Station. The study of their annealing for the removal of casting strains and the improvement of physical properties. The investigation, which will include aluminium, will be under the supervision of R. J. Anderson, of the American Bureau of Mines.

Chromium in Steel.

R.D. Report No. 35, issued by the Research Department, Woolwich, deals with the subject of "The Influence of Chromium on Steel," by MR. H. MOORE. According to the General Summary of Results and Conclusions, a series of chromium steels has been investigated, containing carbon 0.25 to 0.39 per cent., chromium varying from 0.25 to 6.4 per cent. Three other steels were also examined containing carbon 0.40 to 0.57, chromium 4 to 5.8 per cent.

The facts brought to light by the mechanical tests and by the preliminary work undertaken to determine the most suitable treatment may be summarised as follows:—

(1) *Position of Critical Ranges on Heating and Cooling.*

(*a*) Increase of chromium content lowers the point Ar. 3 and raises Ar. 1. With 2.56 per cent. chromium, 0.39 per cent. carbon, Ar. 3, 2, 1 are merged into one critical range, even when the cooling is very slow (3 deg. C. per min.). All the alloys with higher chromium content, including two with carbon 0.25 per cent., showed only one critical range on cooling. The alteration in position of Ar. 1, due to increased chromium content, is considerable (*e.g.*, about 60 deg. C. for 6 per cent.).

(*b*) Ac. 1 is raised by increase of chromium content to about the same extent as Ar. 1. The alloys have only one critical range on heating, Ac. 1, 2, 3, except in those containing sufficient chromium to raise Ac. 1, 3 above Ac. 2.

(*c*) A break in the heating curves of the high chromium steels, occurring at about 775 deg. C. (below Ac. 1), has been found to coincide with the temperature at which the steel becomes non-magnetic. This critical point is therefore Ac. 2.

(*d*) The form of the heating curves of the high-chromium steels in the neighbourhood of Ac. 2 appears to indicate that the thermal change is either an absorption of heat extending over a considerable interval of temperature and ending sharply at Ac. 2, or is due to some such cause as an alteration in specific heat. The change is certainly not an absorption of heat occurring at a definite temperature.

(*e*) Increased speed of heating raises Ac. 1, 3: increased speed of cooling lowers Ar. 3, 1. This effect appears to be greater as the chromium content increases.

(*f*) The temperature difference between Ac. 1 and Ar. 1 is considerable, 40 deg. C. in some cases.

(*g*) The position of the critical range on cooling is, in the steels containing 3 per cent. or more chromium, distinctly lowered by raising the initial temperature. The effect is greater with the high-chromium steels.

(2) *Relation between Quenching Temperature and Hardness, and between Annealing Temperature and Rate of Annealing.*

(*a*) Hardening on quenching commences at the lower limit of the Ac. 1, 3 range, and rapidly becomes much more intense as the quenching temperature rises through the critical range. With high-chromium steels the hardness obtainable appears to increase with quenching temperature after the critical range has been passed.

(*b*) Annealing proceeds at the maximum speed at a temperature immediately below Ac. 1, and is less rapid the lower the temperature.

(*c*) The presence of chromium retards the annealing effect of re-heating. The higher the chromium content the more slowly does annealing proceed at a given temperature, other things being equal.

(3) *Refining Temperature.*

(*a*) The finest grain appears to be obtained by heating the steel slightly above Ac. 3 and quenching.

(*b*) A finer grained fracture can be obtained in chromium steel (1 per cent. chromium or more) than in carbon steel of the same carbon content.

(*c*) The presence of chromium tends to prevent the growth of the crystals when the steel is heated above Ac. 3.

(4) *Relation between Rate of Cooling and Constitution and Microstructure.*

Chromium has a powerful effect in interfering with the change which takes place at Ar. 3, 1, *i.e.*, in tending to prevent the separation of ferrite and formation of pearlite. With high-chromium steels cooling requires to be extremely slow to produce ferrite and lamellar pearlite. In steels with 2 per cent. or more chromium the rate of cooling need not be nearly so rapid as in carbon steels to maintain the carbon in the diffused condition.

(5) *Mechanical Tests.*

(*a*) The most suitable treatment consists essentially of (1) rapid cooling from a temperature slightly above Ac. 3; (2) annealing at a temperature just below Ac. 1, or at lower temperatures if complete annealing is not desired. The rapid cooling need not be nearly so rapid as for carbon steels to produce better results.

(*b*) The mechanical properties of chromium steel slowly cooled through the critical range are little if any better than those of carbon steel.

(*c*) More improvement can be effected by heat treatment in chromium steel than in carbon steel.

(*d*) In slowly cooled medium-carbon steel increase of chromium raises the maximum stress and correspondingly reduces the elongation up to about 2.5 per cent. chromium. With increase of chromium over about 3 per cent. the maximum stress appears to fall off, the elongation again rising. The resistance to shock of steel slowly cooled through the critical range is low.

(*e*) In steels suitably treated—(1) Increase of chromium up to 2.5 per cent. raises the maximum stress, which is not notably affected by a further increase of chromium from 3 to 6.5 per cent. (2) The proportionate increase in maximum stress with increased chromium is much greater in the partially annealed than in completely annealed steels. This is a corollary of (2) (*c*) above. (3) The ratio of yield point to maximum stress increases considerably as the chromium content rises up to about 3 per cent., and remains high for higher percentages. The yield point is 80 per cent. or more of the maximum stress for the steels containing more than 2 per cent. chromium. (4) Elongation falls off somewhat as maximum stress rises, but remains high. Contraction of area is good in every case. (5) The addition of chromium considerably improves the mechanical properties of the steel, as indicated by its behaviour under static tensile stress, without impairing its resistance to shock. (6) By varying temperature and length of annealing a wide range of properties may be obtained in any one chromium steel (containing 1 per cent. or more). This fact renders the comparison of steels of different compositions a matter of some difficulty. (7) The maximum improvement in mechanical qualities in steel with 0.30 to 0.40 per cent. carbon seems to be effected by the addition of about 3 per cent. chromium.

(*f*) As the rate of annealing of chromium steel (with, say, 2 per cent. or more chromium) on re-heating, after hardening, to temperatures below Ac. 1, is much slower than that of carbon steel, the heat treatment admits of stricter control.

(6) *Microstructure of Chromium Steels.*

(*a*) A peculiar fern-like pattern developed by etching the higher-chromium steels and only discernible with a low magnification appears to be due to the mode of crystallisation on solidification.

(*b*) The carbon content of pearlite appears to be reduced by increase of chromium. The equilibrium curve (obtained from the cooling curves) points to the same conclusion. The conditions of equilibrium require investigating much more fully before this effect can be expressed quantitatively.

(*c*) Suitably treated chromium steels present an amorphous appearance under the microscope. The state of division of the constituents appears to be so fine that they are not resolved by high powers. A fine sorbitic structure is much more readily obtained in these steels than in carbon steels.

(7) *Chemical Constitution of Chromium Steels.*

(*a*) Chromium exists in steel, (1) dissolved in the iron, (2) as carbide, with carbide of iron.

(*b*) The existence of double carbides of iron and chromium, of definite composition, appears to be improbable. The two carbides seem to exist together in all proportions.

(*c*) The relative proportions of the total chromium existing in the two forms are greatly influenced by the heat treatment of the steel.

(*d*) Owing to the difficulty of estimating carbon as carbide, the formula of the carbide of chromium has not been established. It is possible that there are several carbides.

(*e*) When a hardened chromium steel is annealed below Ac. 1 the percentage of iron and chromium

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existing as carbides increase as the annealing is further continued, the hardness correspondingly diminishing. It appears to be impossible for all the chromium to exist in the state of carbide. For the steels examined it is difficult to reduce the percentage of chromium in solid solution in the iron to less than 30 per cent. of the total chromium by annealing or otherwise.

(*f*) The annealing effect, involving a decrease in hardness and an increase in the percentage of carbides, commences on re-heating hardened steels at a comparatively low temperature. The change proceeds the more rapidly the higher the temperature. At any given temperature the rate of change diminishes with time, *e.g.*, on heating a hardened chromium steel to a temperature, say, 30 deg. C. below Ac. 1, the annealing effect at first is rapid, gradually becomes slower, till after several hours at that temperature the change proceeds very slowly. The change still proceeds even after heating has been long continued; the approach to a state of equilibrium is gradual.

(*g*) The ratio between iron as carbide and chromium as carbide does not remain constant for the same steel in different states of hardness.

(*h*) Over-heating appears to have little, if any, effect on the ratio of iron as carbide to chromium as carbide.

(i) Chromium as carbide may be estimated with considerable accuracy, and the results are a valuable indication of the mode of existence of the carbon, and thus of the mechanical qualities of the steel.

The Composition of Die Block Steel.

In preparing a specification for die blocks many points require to receive adequate attention. In particular the nature of the services which the blocks have to perform must be borne carefully in mind. These services vary greatly from block to block, depending upon the size, the nature of the pattern, and the shape of the block. Whether or not the block has to be hardened before use also affects the problem very considerably. Allowing these variations, there are certain fundamental properties of die blocks which must be found in every one. These appear to be as follows:—(1) Reasonable cost; (2) metallurgical soundness and homogeneity, freedom from pipe, etc.; (3) easy machinability supplied; (4) capacity for hardening to a moderately high figure, and to a reasonable depth, even in large masses; (5) capacity of submission to normal heat treatments; (6) highest possible toughness. This must be found in all directions, and postulates a considerable freedom from slag and non-metallic impurities, as well as comparative freedom from undue fibre in the state as delivered. (The latter property is a reflection of the extent to which the block is forged.) (7) A general high value of yield point—in order to provide bulk rigidity in the block.

Most of these properties are fairly well known for different steels. The cost of the block renders it desirable that the steel which is used should be fairly simple—*i.e.*, should not contain any unduly high proportion of alloying elements. Naturally, of course, the cost of a block must be regarded in conjunction with the length of life which it enjoys, and if it could be established that a markedly greater durability resulted from the use of a steel which had a high initial cost, the steel would fulfil the first requirement given above.

The necessary strength (property 7 above) can be obtained from plain carbon steel, provided that the proportion of carbon is high enough. This, however, generally tends to depress the toughness, and it is desirable to use a steel of a composition which tends to the higher orders of toughness (this, of course, is relative). The addition of a small proportion of nickel to the steel has this general effect, and the additional expense incurred by such an addition is thoroughly repaid by the superior toughness of the product. The presence of this element will keep up the rigidity, will render the steel more responsive to heat treatment, and will not in any way interfere with the machinability.

Having in mind these properties, a steel of the following chemical composition has been tried under various conditions:—Carbon, 0.64 per cent.; silicon, 0.23 per cent.; manganese, 0.65 per cent.; sulphur, 0.024 per cent.; phosphorus, 0.024 per cent.; nickel, 1.00 per cent.

This steel has been tested under three sets of conditions:—(*a*) As small blocks in the unhardened state; (*b*) as small blocks after hardening and tempering to various extents; (*c*) as large blocks in the unhardened state.

In the first test (*a*) on patterns which were such as imposed a considerable stress on the block the results were not satisfactory. For condition (*b*) the same blocks, bearing a similar impression, were quenched for hardening and were then tempered at suitable temperatures. Tested after this treatment they gave excellent results, the durability of these blocks being about 25 per cent. greater than those of ordinary die blocks as previously employed, working on similar material. In the third condition the blocks have not had very exhaustive treatment, but so far as the tests have gone they show that under such circumstances the blocks give a very good life.

The general result of the tests is that the steel is a very satisfactory one for use in die blocks.

In order to test the material mechanically as well as chemically, a special piece of the same steel as the block should be employed. It is desirable to know the strength and the toughness of the material. The strength is provided for by the Brinell hardness test, which for this steel should be between 207 and 241. The toughness—in order to provide adequate information as to slag lines, etc.—should preferably be tested in two directions at right angles to each other. This can be performed most readily upon the separate specimens—which can be conveniently 3 in. square—forged down from a piece of the steel which provides the block. When normalised, the notched bar value on a longitudinal test piece should not be less than 10 ft. lb. and on the transverse specimen should not be less than one-third of the value given by the longitudinal specimens.

The material should be supplied in the normalised condition, the normalising temperature being 830 to 850 deg. C. The steel should be hardened from the same temperature and tempered according to requirements.—*The Drop Forger.*

Publications Received.

"Power of Print," a magazine for advertisers, edited by Chas. E. Penwarden. Chas. B. Penwarden & Company, Station Buildings, Altrincham, Manchester.

"The Industrial League and Council Journal," November, 1921, price 3d. The Secretary, Central Office, 82, Victoria Street, S.W.1.

"The Hague Rules, 1921, discussed from the business side by one who was there," by L. C. Harris. 2s. net. Effingham Wilson, 54, Threadneedle Street, E.C.2.

"The Labour Co-Partnership Association," thirty-fifth Report, 1920, price 6d. Office: 6, Bloomsbury Square, London, W.C.1.

Messrs. Archibald Baird & Son, Limited, the Clyde Steel and Engineering Works, Hamilton, near Glasgow, forward their new catalogue, "Steel Castings," with illustrations of works departments and chief foundry products.

HIS MAJESTY'S TRADE COMMISSIONER at Cape Town (Major G. Fetherston, D.S.O., M.C.) reports that a South African Municipality would be glad to receive quotations from United Kingdom firms for galvanised iron dust-bins with covers. United Kingdom firms interested in this matter may obtain the address to which quotations should be sent, on application to the Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1.

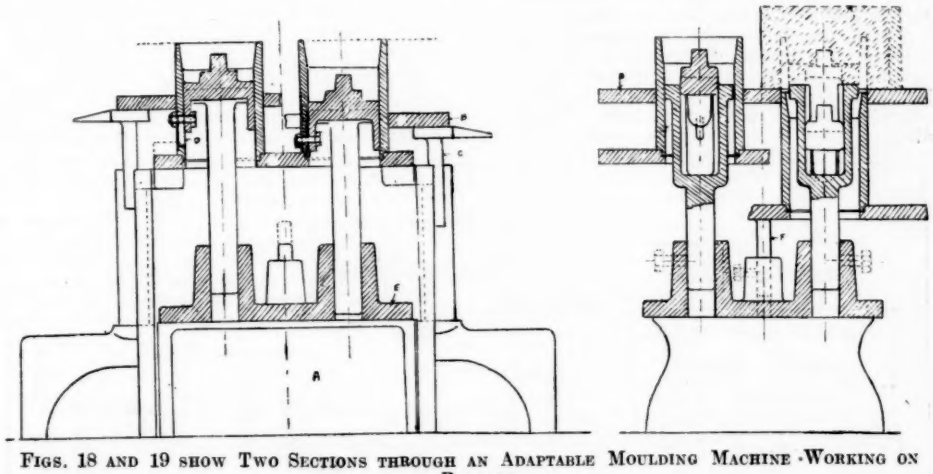
TENDERS for the construction of a bridge over Sydney's harbour were called for on October 8, and it is reported that the Government of New South Wales intends to send the Chief Engineer of the State, who has designed the bridge, to Canada, the United States, and Great Britain during the coming year, where he will afford any information required. The notice calls for tenders for the substructure and superstructure of a cantilever bridge embracing a span of 1,600 feet clear from the centre of the main piers. The total length to be tendered for is 3,816 feet, the deck to include four lines of railway and a roadway 25 feet wide between trusses, with a footway 15 feet wide cantilevered outside the western side, and a motor roadway 18 feet wide on the other side.

Belt Pulley Castings.—II.

By Ben. Shaw and James Edgar.

Moulding Machines.

In dealing with pulleys to be produced in large quantities, whatever size they may be required, and the suitability of machines, the moulds should receive first consideration. There is scarcely any limitation to the work that can profitably be done on moulding machines nowadays, and makers are so enterprising that they are always willing to advise and suggest alterations that will meet specific needs. American foundries were early to grasp the great potentialities of the moulding machine, and it is sometimes thought that in this field the Americans are far ahead of us. It is not so. All the time new improvements are being made in British machines. Pulley moulding, and especially small deep pulley moulding, is admirably suited for machine work, and the ingenuity of British machine makers is well borne out by the special arrangements for moulding pulleys of different depths from the same pattern, such as are illustrated in Figs. 18, 19, and 20, and designed by the Adaptable Moulding Machine Company, of Birmingham. At first sight the arrangement may appear involved, but it is really very simple. A (Fig. 18) represents the body of the machine. The stripping plate B (Figs. 18 and 19) is raised or lowered by means of the adjusting strip C, and this regulates the depth of the pulleys. The adjusting strips are wider than the machine table, and have two slotted lugs to facilitate adjustment by set-screws. These strips are clearly shown in Fig. 20. Slots are also provided in the sides of the pulleys for setting them in relation to the boss and ribs as indicated at D (Fig. 18) and at H (Fig. 20). Some support is necessary for the stooling pillars (Fig. 18), which are adjustable, and this is given by means of the base E, which is fitted on the table of the machine. A set-screw is fitted into each boss, which enables the pillars to be fixed at any required height. F (Fig. 19) is a stop which can be set to whatever draw is required. Fig. 20, which is a plan view with the stripping plate removed, shows on the left-hand side a pattern in position, the lugs H being for the purpose of bolting it to the table. On the right-hand side the rim pattern is removed, and the boss and ribs only shown. The patterns shown in Fig. 18 are set for different depths, and attention may be drawn to the adjustments of the stripping plate, the stooling pillars, and the pulley boss and ribs. Fig. 19 illustrates how the arrangement works. When the table is lowered the pattern and boss deliver from the mould, but the stooling pillar remans stationary, of course. Good results are obtained by this method. As the drawings indicate, the pulleys are fitted with recesses turned in the pattern plate.



FIGS. 18 AND 19 SHOW TWO SECTIONS THROUGH AN ADAPTABLE MOULDING MACHINE WORKING ON PULLEYS.

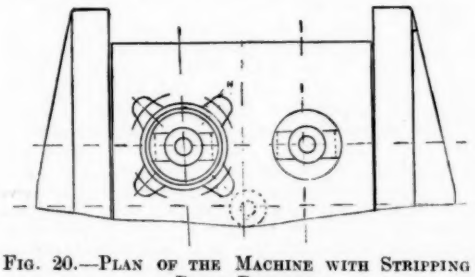


FIG. 20.—PLAN OF THE MACHINE WITH STRIPPING PLATE REMOVED.

Apart from the point of view of first cost, there is no reason why a similar method should not be adopted for solid-cast pulleys of larger diameter. There are, however, quite a variety of methods employed to suit the capacity of various moulding machines. A method that is frequently adopted is to make rim, arms, and boss separately, the arms being cut to represent half the thickness required. These are mounted on a plate, a half-rim pattern located about them, and a suitably-sized boss attached. Two impressions are taken for the cope and drag respectively, a jolt ramming machine with a pattern-drawing device being particularly suitable for the work, though hand-operated machines give equally satisfactory results at a slower rate of production. Various rim patterns are prepared to cover the different widths desired for pulleys of the same diameter. The bosses, too, can be changed to correspond with the width of rim and the diameter of the shaft for which the pulleys are required. A spigot and socket joint of standard dimension are used for locating the bosses, whereas the rims are turned to fit about the arms and

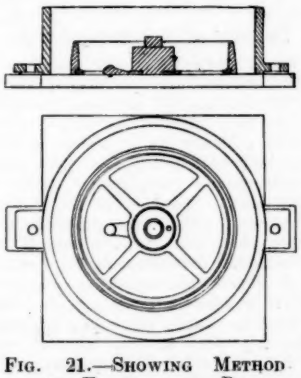


FIG. 21.—SHOWING METHOD OF FITTING THE PULLEY WHEEL ARMS TO THE PLATE.

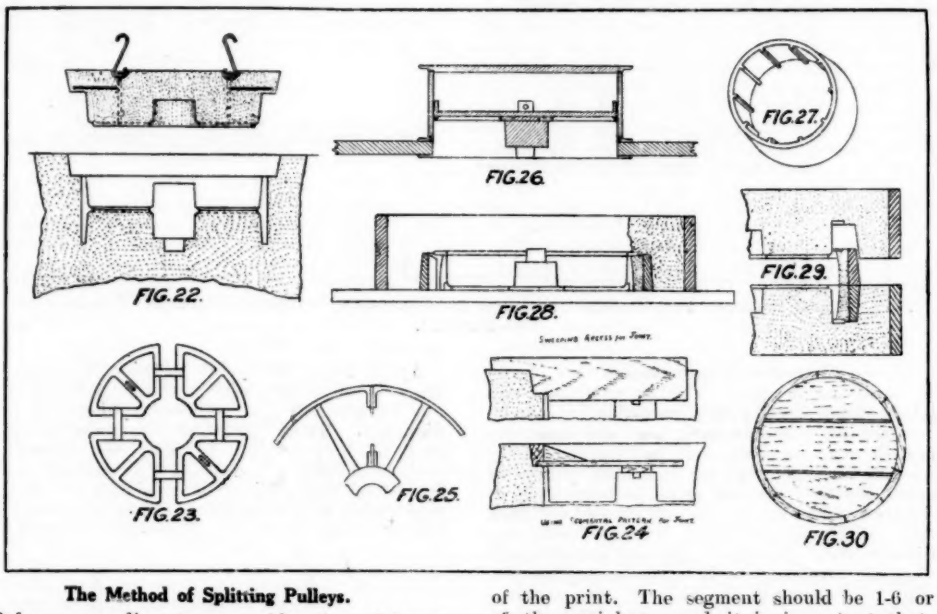
secured to the plates as shown in Fig. 21. This method enables the convexity of the rim to be moulded successfully. The making of full-sized separate pieces is sometimes adopted, both rim and bosses being detachable for varying widths of pulleys. They are not, however, very applicable for moulding on a machine, and consequently are not suitable for rapid production of casting.

Making Pulleys without Boxes.

When there are no facilities for machine moulding, and the number off each width of pulley is comparatively small, the method may be adopted with advantage, as the whole mould can be made in the foundry floor without the use of boxes, as indicated in Fig. 22. It will be noted that the cope is carried by means of a specially prepared grid or plate (Fig. 23), which can be used for other pulley moulds of the same diameter. The tapered joint shown in Fig. 22 is usually swept to shape by rotating a board fixed at the centre of the boss and moving on the rim pattern, or the sand may be rammed against a segmental piece maintained at a definite distance from the centre of the pulley pattern, as shown in Fig. 24. The projection about the cope to form the joint is comparatively small, and can be strengthened by rodding.

Moulding Large Pulleys.

Pulleys of medium and large size having external flanges are rarely called for; certainly it is unusual for quantities to be required for any one size. The preparation of a pattern to be used on a machine is therefore not often necessary, but if the numbers required warrant the expense of preparing a plate then a good method similar to that previously described is illustrated in Fig. 26. Various rim-pattern widths may be used and the boss may be altered, the plate carrying the half-pattern of the arms being prepared, so that it can be located in any of the rims used. This method, of course, involves a three-part box, both the drag and cope impressions being taken from one side of the plate. When it is desired to use a two-part box on a machine then it is necessary to core out the rim. This involves a print on the pattern and a sectional core-box. An iron pattern of this description having a core-print surrounding it would be very heavy, consequently it is better practice to use timber and build it segmentally. There is no reason, however, why the arms and boss should not be made of metal. When this method is adopted the core sections are generally introduced in the mould green, and it is advantageous to have a good taper on the back



The Method of Splitting Pulleys.

Before proceeding to a consideration of larger pulleys, the method of splitting pulleys may be described for the benefit of those unfamiliar with it. Lugs are cast on the rim and boss, and while these do not add to the appearance of the casting, particularly when the arms are curved, it is of little consequence compared with the effectiveness of the result. In Fig. 25 the flanges on rim and boss are shown in a straight line; though this is impossible when the arms are curved, it does not make any material difference in the finished pulley. In order to locate the splitting plate or core in the mould it is necessary to attach prints to the flanges. Bottom and side prints will suffice, leaving the top clear so that no risk of crushing the cope is possible. The splitting plates are usually of wrought iron, about $\frac{1}{4}$ in. or $\frac{3}{8}$ in. in thickness, their shape being determined by the prints and the size of the lugs. It is customary to cast holes through the lugs for bolts, corresponding holes being drilled through the splitting plates, into which cores are introduced of sectional shape similar to the bolt holes desired, and in length equal to the thickness of both lugs and the splitting plate. These division plates are frequently inserted into moulds without any covering, and, providing the iron plates are free from rust, the pulley casting can be readily split. In other instances the plates are given a coating of clay-wash and plumbago or blacking may be used, so long as it does not peel when dried. This method is employed when cast-plates are used instead of wrought-iron. The coating ensures the easy separation of the sections.

of the print. The segment should be 1-6 or 1-8 of the periphery, and it is important that the corebox should be accurate, or, if anything, slightly under the correct length. When, as occasionally happens, a flanged pulley is called for similar in size and width of a standard pattern mounted on a plate, but without flanges, as shown in Fig. 21, it is possible to use it for moulding purposes without incurring much expense, and as it frequently saves the preparation of a new pattern, it has a certain economic value. A flange of the desired size, and preferably of metal, is made and dowelled to rim on the pattern plate. Two cast-iron rings are also required tapered on the outside, as shown in Fig. 27, and having the projecting plates on the inside to give support to the sand. Holes are drilled in the joint edges and tapped for convenience in introducing lifters, and if corresponding holes are drilled through the pattern plate so that each ring may be placed concentric with the pattern, they can be secured to the plate. Sand is rammed between the ring and the pattern and a joint made to correspond with the top edges of the rim and the iron ring. The flange is then located and the remainder of the box rammed up as shown in Fig. 28. A pattern drawing machine may be used to obtain a clean withdrawal; in any case the drag may be lifted, leaving the ring about the pattern on the plate, when the flange may be removed, leaving the ring free. This can easily be inserted in the drag. The same proceedings are necessary in preparing the cope, but instead of returning the ring to the cope after stripping, it should be located on the drag, and the cope lowered over it, as indicated in Fig. 29.

It must be distinctly understood that the use of cast-iron rings to carry the impression between the external flanges on the rim is only recommended when an ordinary pulley pattern, of similar size to that required, is already prepared and mounted on a plate. Any slight modifications such as the introduction of lugs for making a split pulley does not affect the principle involved. When a few castings are required the moulds can with advantage be prepared on a hand-ramming machine with a pattern-drawing device in order to facilitate the clean withdrawal of the pattern.

Pulleys with Internal Flanges.

Pulleys with internal flanges are usually cored out in order to limit the number of joints in the mould which would otherwise be necessary. The pattern for this pulley, a plan of which is shown in Fig. 30, is not difficult to make. The rim is built of laminæ of segments and turned, care being taken to give sufficient taper to ensure its free delivery from the sand. The prints on the top and bottom need not be made more than 1 in. in thickness, though a print on the top is not always necessary. It depends on the method of moulding. If the pulley is of the medium size, and a half pattern can be mounted on a plate, then the prints can be used in both top and bottom. In such cases the core may be made in two sections, jointed horizontally through the centre of the arms. A half core box would be necessary, carrying the half sections of the arms on a bottom plate. While the half box would suffice for two-core sections without alteration when the arms are straight, it is necessary to prepare additional half-arm sections when they are required to be curved so that the box can be altered for the reverse half of the core.

Colloidal Theory of Rust.

DR. NEWTON FRIEND signalised his recent appointment as head of the Chemistry Department of the Birmingham Municipal Technical School by lecturing, on November 24 before the Birmingham Metallurgical Society, on "Recent Progress in the Study of Corrosion."

After examining various theories to account for the phenomena attendant upon corrosion, Dr. Friend directed attention to the "colloidal theory" which had been formulated by himself, and which, he said, reasonably accounted for the facts. If moving water was increased to a velocity of eight miles per hour, no corrosion of immersed metal took place. According to the colloidal theory, corrosion of iron in a neutral solution of water was entirely distinct from corrosion in acid. Iron first passed into solution through the presence of electrolytes, gradually developing a solution of ferrous hydroxide, which eventually produced oxidation. The solution, however, could be removed by rapidly flowing water, thus inhibiting corrosion. The same retardation could be effected if the colloid was coagulated either by physical or chemical precipitants.

Particulars were given of various experiments made to test the theory. Solutions containing alcohol reduced rust relatively to the increase in alcohol.

On the question of the effect of temperature on the rate of corrosion practically nothing was known. But experiments had shown that at 80 deg. C. iron corrodes nearly ten times as rapidly as at 0 deg. The effect of light was very remarkable. Light was shown to accelerate corrosion very markedly, even after the temperature effects had been removed. Corrosion was clearly affected by barometric variation. The subject was very complex, and the results were not always the same, even when experiments were carried out under what appeared to be exactly identical conditions. The lecturer expressed the hope that further experiments would indicate the bearing of the colloidal theory upon the corrosion of ferrous alloys and non-ferrous metals.

MESSRS. G. W. NORRIS. S. H. Crosfield and C. K. Butt, engineers and machinists, Orchard Street and Dorset Street, Blandford, trading under the style of W. A. Foot & Company, have dissolved partnership Messrs. G W. Norris and S. H. Crosfield continue.

Foundry "Inquests."

By F. C. EDWARDS.

The foundry, directly or indirectly, plays a vitally important rôle. Actual castings may not be visible in the finished article, nevertheless, even in these cases a little inquiry invariably proves that at some time or other in their history castings were indispensable to their production.

This article is an attempt to show that the cultivation of the foundry point of view, with the corresponding manifestation of practical sympathy arising from a realisation of foundry troubles, by the other branches of engineering, cannot fail to be in the long run to their mutual credit.

The watchword to-day is co-operation, but there are still factories in which each section functions as though its interests began and ended with the success of its own department. This may be due to a policy of a management that insists upon a complete segregation of departments for costing purposes, whilst ignoring the interdependence of all sections, and overlooking the fact that a little extra cost judiciously incurred in one department often leads to material economies in another. Again, the existence of these rigid sectional interests may be due to a faulty administration that promotes a fallacious interdepartmental competition, obviously there cannot be true competition between shops engaged in different kinds of work. In any case, none can deny that the existence of this state of things is fairly prevalent.

Under these conditions, a scapegoat becomes a matter of expediency. What could be more inevitable than that the foundry should often be found in this position? In the well-ordered drawing office stresses and strains are carefully calculated, and none dare question their accuracy. In the pattern-shop which deals with the setting-out of the job and its templates, all is quite clear. The assembling or engineering department is concerned merely with the discovery of the error or blemish. Having stumbled over one, perhaps, by accident, the moment is delayed when it may assume the sole creatorship of the finished article. The foundry alone is conscious of possible shortcomings, doubtless due to the legion of physical, chemical and thermal problems affecting the foundry still awaiting solution, and it generally accepts the inevitable.

After having taken part in some scores of "inquests" in various shops, the writer is forced to the conclusion that the foundry is far too often a convenient scapegoat, and this to the detriment of everyone concerned. This does not mean that the foundry is not, perhaps, the most liable to err of all departments. Yet this but serves to emphasise the point to which attention is particularly directed, viz., that the other departments have it in their power, to a greater extent than is commonly supposed, to simplify and reduce the problems confronting the foundry, thereby effecting a corresponding diminution in the need for the "inquests."

Obviously, the pattern-shop can smooth away many difficulties and facilitate foundry production to a considerable extent. Failure to make provision for all possible contingencies during the progress of the job through the foundry is, therefore, inexcusable on the part of the pattern-shop.

The engineering department, in order to save machining costs, may demand an absurdly high standard of perfection in castings supplied, holding, apparently, to the belief that if a sand casting weighing, say several cwts., does not come out as perfect as a die casting of a few ounces, the cause is gross negligence on the part of the foundry.

The design often places the foundry between "the devil and the deep sea." And this is probably the most poignant of cases. The drawing office, on the one hand, may fail adequately to realise the difficulty in the way of obtaining a satisfactory casting as designed. On the other hand, the foundry, perhaps not being sufficiently used in the requirements of the job to justify the suggesting of alternatives, struggles on in a vain endeavour to placate the drawing office by attempting to produce the impossible. The irony of the situation is, that a simple alteration in design is frequently all that is needed to satisfy their mutual requirements.

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Gas in the Foundry.*

By A. Docking.

Towns gas has for many years been a keen competitor of solid fuel, but to-day its high cost and low calorific value has made its use on a large scale prohibitive, and consequently many industrial consumers are installing their own gas-making plant. Two large plants have recently been installed in Coventry, with a result that the Gas Committee decided at their last meeting to reduce the price to their large consumers to 2s. 6d. per 1,000 cu. ft.

The figures in Table I. are based on the returns of the Gas Department at the year ending December last. From these figures it will be seen that the loss per 1,000 cu. ft. sold will be 7½d., and, as stated at their last monthly meeting, a loss of revenue of over £34,000 per annum.

The figures for the cost of suction gas made on the consumers' premises from anthracite coal plant would be over 26,000,000, and, therefore, if gas undertakings wish to compete with suction gas they have to supply a low-grade gas made by the complete destructive distillation of the coal. This low-grade gas, known as suction gas, is not novel as applied to industry. Thousands of plants are in daily use in this country for the driving of gas engines, and it has given the same satisfaction as town's gas at one-third the running cost. In the same way, as B.Th.U.s can be applied to the driving of internal combustion engines so they can be applied to industrial heating. Obviously one B.Th.U. is as good as another, and that whatever town's gas can do, so can suction gas.

TABLE 1.—*Cost Comparison between Coventry Town's Gas and Producer Gas.*

Town's Gas, per 450,000 B.Th.U's.		*Producer Gas, per 450,000 B.Th U's.*	
	Pence.		Pence
Coal and equivalent	30.90	Coal and equivalent	12.05
Purification	0.32	Purification and water	0.63
Salaries	1.04	Salaries	—
Wages	3.06	Wages	1.89
Maintenance	10.66	Maintenance	1.20
Collection	0.52	Collection	—
Stationery, etc.	0.50	Stationery, etc.	—
Miscellaneous	0.38	Miscellaneous	0.24
Rates and taxes	1.25	Rates and taxes	—
Capital charges	6.04	Capital charges	2.40
	4/6.67	Power	2.00
Reductions :—			
Sale of Coke 11.73			
Sale of Tar 2.26			
Sale of NH_3 .. .. 2.34			
Stoves, etc. 0.35			
Miscellaneous 0.45			
	1/5.13		
	3/1.54	Total	1/8.41
37.54 pence.		20.41 pence.	

Table 1 shows the comparative number of heat units, from different fuels, that can be purchased for a given sum of money. The size of each illustration is in direct proportion to the heat units available, so that it can be seen at a glance that petrol is the most expensive, and gas coke the most economical, method of producing heat units. It will be noticed that although oil contains 4.5 times the heat units of petrol, per unit cost, nevertheless it only contains about one-third the heat units of gas coke.

Heat Value of Fuels.

Fig. 1 shows the comparative number of heat units, from different fuels, that can be purchased

show that town's gas at 2s. 6d. per 1,000 cu. ft. is still 9½d. per 1,000 cu. ft. dearer than suction gas, and that with this reduction it pays the large user to instal his own plant. The price of Coventry gas at 2s. 6d. per 1,000 cu. ft. will be the cheapest gas in the British Isles.

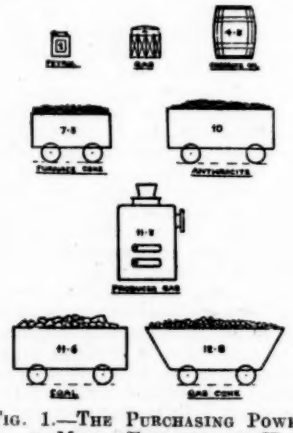

FIG. 1.—THE PURCHASING POWER OF MONEY EXPRESSED IN HEAT UNITS OF FUEL.

The reason why gas can be produced on the consumers' premises cheaper than at the gasworks is that the latter have always given more attention to the manufacture of by-products than to the manufacture of gas. The total B.Th.U.s in a ton of coal is 31,340,000, and the amount taken from this in gas at the gasworks is only 6,000,000, or less than one-fifth, the remainder being left in the coke, tar, etc. The amount produced from the same ton of coal by a suction gas

Combustion of Solid Fuel.

The process of the direct burning of coal and similar solid fuels may be divided into three stages, the first being the driving off of volatile matter in gaseous forms which takes place at a comparatively low temperature and independent of any air supply. The second stage is that of the residue—which is mostly carbon—burning with what is called primary air. The third stage takes place when the volatile gases, already being given off, combine with the oxygen of what is called secondary air, and burn as a flame on the top of the fire. Combustion of these gases only takes place at a relatively high temperature. Hence, if the top of the fire is cold combustion will not take place, in which case most of the gases from this volatile matter will pass into the flue in an unburnt condition.

Disadvantages of Solid Fuel.—With all forms of solid fuel, whether employed for direct or indirect firing, the fuel has to be handled, generally by hand, to the furnace, and the clinkers and ashes have to be removed at frequent intervals, which work involves both time and labour. In one engineering firm in the Leeds district the coal and ash wheeling alone amounts to not less than £2,000 per annum.

The temperature of the solid-fuel fire is continually fluctuating, and the opening of the furnace door and feeding with fresh fuel will always cause a drop in the temperature, and when the fire is completely burnt through the heat given off is then in excess of that required.

* A Paper presented before the Coventry Branch of the Institution of British Foundrymen on November 16.

Pulverised Fuel.

Many of the drawbacks of solid fuel can be eliminated by the use of pulverised fuel. With this system the coal is first crushed, then dried, and conveyed to the pulveriser, where it is powdered to a high degree of fineness. It is fed to the furnace through suitable piping by means of compressed air. Very high efficiencies and uniform temperatures are obtained with this system of firing, and low-grade fuels with a high per cent. of ash can be used. Although pulverised fuel has many advantages, it can only be used in very large works, as otherwise the initial outlay on plant is very heavy, and the saving effected, after allowing for all on cost charges, would not be a business proposition.

Gaseous Firing.

Fig. 2 shows the distribution of B.Th.U.s after distillation of coal, according to modern works practice.

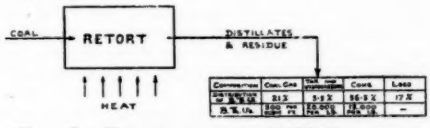

FIG. 2.—DISTRIBUTION OF B.TH.U.S AFTER DISTILLATION OF COAL.

The calorific value of the gas is approximately 450 to 500 B.Th.U.s per cu. ft.

Classification of Gases.

Fig. 3 shows the different gases which may be produced from the bituminous coal or anthracite. The direct distillation of coal produces coal or coke-oven gases together with coke. When coke or anthracite is used in a gas-producer plant, and steam is passed through the fuel bed, water gas is produced. When, however, air and steam are passed through the fuel bed alternatively, in opposite directions, semi-water gas is formed. By passing air and steam through the fuel bed in one direction only the gas known as producer, or suction, is made. In certain metallurgical operations air comes into contact with incandescent coke, and this produces what is known as blast furnace gas. It will be seen from Fig. 3 that the calorific values of these gases vary from 500 to 100 B.Th.U.s per cu. ft., but after the requisite amount of air has been added the calorific value of the mixtures varies from 83 to 70 B.Th.U.s

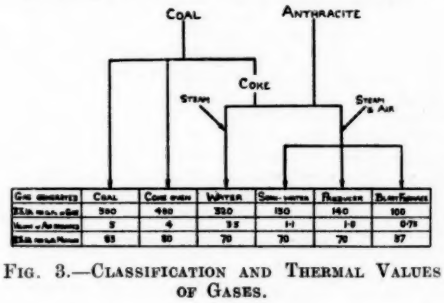

FIG. 3.—CLASSIFICATION AND THERMAL VALUES OF GASES.

per cu. ft. apart from blast furnace gas. Although there is a considerable difference between the calorific values of the original gases, yet after each gas has received its correct volume of air to ensure complete combustion the final mixtures contain almost the same number of B.Th. U.s.

Generation of Producer Gas.

The first stage for the production of producer gas takes place in the combustion zone of the generator where the carbon of the coke combines with the oxygen of the incoming air and forms carbonic acid gas, which passing through the central portion of the fire, called the reducing zone, splits up into carbon monoxide and oxygen. The latter combines with a further quantity of carbon, and again forms carbon monoxide, whilst the volatile gases are driven off in the distillation zone. When, however, there is a presence of water in the form of steam, the oxygen of the water combines with a further quantity of carbon again forming carbon monoxide, releasing hydrogen which is consequently also present in the gas. The nitrogen of the atmosphere passes through the fire unaltered.

No separate boiler is required for modern plants, as the steam required for passing through the fuel bed can be generated by the heat of the gas made inside the generator. This arrangement increases the efficiency of the plant, besides making the generator a self-contained unit. The gases after leaving the generator pass through a scrubber, in order to remove the foreign matter present. A scrubber generally consists of a vertical bed of coke through which water is sprayed, and the irregular path of the gas through this bed causes particles of tar to be deposited, the latter being washed away by the water. When additional cleansing is required the gas passes through a purifier comprising a number of trays filled with iron oxide or other suitable material

Advantages of Gaseous Firing.

Gaseous firing possesses distinct characteristics of its own, and in recent years has become increasingly popular for heating purposes. It is both reliable and labour-saving, besides ensuring more uniform quality than can be obtained by the use of solid fuel. Additionally, it is clean to use, can be distributed to any desired point, and is undoubtedly the cheapest of all fuels in this country. Moreover, it can readily be used for internal heating, which is often a very desirable feature as against external heating, which is necessary with solid fuel. When furnace work is required, the operator has merely to turn on the supply and light up. Practically no further attention is required, and the temperature can be regulated to within close limits with the assurance that it will remain constant. Producer gas is most economical, as it can be generated at approximately one-third of the cost of coal gas after allowing for capital outlay, maintenance and depreciation.

Applications of Producer Gas in Works.—There is, indeed, an enormous scope for gaseous firing, not merely for engineering purposes, but for all industrial applications of heat. Thus it can be conveniently and economically applied to chemical, glass, salt, wire, sugar, textile and metal-smelting works, besides being particularly adaptable for breweries and bakeries.

Perfect Combustion.

Perfect combustion only takes place when the gas receives a full and sufficient supply of air, and under these circumstances it does not matter whether the flame is white, straw or blue, for in each case the whole of the B.Th.U.s contained in the gas will be converted into heat. It therefore follows that if each type of flame produces the same amount of heat, then the heat of the white flame, being spread over a greater area, is not so intense as the heat of the blue flame, which is shorter and therefore more concentrated.

A low intensity flame cannot be used for high temperature heating, hence in cases where intense local heat is required, the blue or colourless flame should always be used. Providing, however, that the whole of the B.Th.U.s contained in the gas are being utilised for doing useful work, it does not matter what kind of a flame is employed.

Perfect combustion depends upon the correct mixing of the gas and air. When a white flame is employed the correct adjustment can be easily determined by its luminosity, for a flame which is producing its maximum amount of light is having all its B.Th.U.s completely burnt. When a blue or colourless flame is used, the proportions of gas and air should be adjusted so that the small adjacent portions of brickwork or other refractory material give out the greatest possible amount of luminosity. When this obtains, the maximum amount of heat is being produced.

Imperfect Combustion.

Complete combustion cannot take place without heat. If, for example, a coil of wire be passed over a candle flame the latter will be immediately extinguished. If the gases, in gaseous firing, impinge upon a cold surface before proper combustion has taken place, combustion will be arrested and B.Th.U.s will be wasted. This can be exemplified by placing a kettle with a clean

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metallic bottom, filled with cold water, over a Bunsen flame. At the commencement, when the water is cold, the gas flame stretches beyond the bottom and up the sides of the kettle. This is due to the fact that there is a relatively cold zone of unburnt gases underneath. This zone of unburnt gases is a poor conductor of heat, and prevents a rapid increase in temperature. When, however, the bottom of the kettle has warmed up improved combustion will result, and this can be observed by watching the contraction of the flame. It will be readily appreciated that a cold surface in the vicinity of combustion produces waste which might lead to a serious loss if permitted on a large scale. In modern boiler construction provision is made for a large flame area, so that the relatively cold plates of the boiler will not interfere with combustion.

In the reverberatory furnace a long, white flame is often used. But it has been shown that when the air is added outside the flame, the latter extends a considerable length, and, owing to the volume occupied by it, has little intensity. Hence when it comes in contact with a cold body the combustion of its hydro-carbons will be arrested and free carbon deposited. Thus, upon lighting up the furnace carbon is deposited upon the cold walls. The same takes place when cold material is put in the furnace, and this deposition of carbon is a direct loss of B.Th.U.s. This tendency of a white flame to drop its carbon is disadvantageous, and, when circumstances permit, a blue flame should be used in preference.

(To be continued.)

Tests of Built-up Columns.*

The author analyses the conclusions to be drawn from the test to destruction of two columns, carried out by Professor Rudeloff. The first column, 23 ft. 9 in. long, was made up of four 0.67-in.-thick plates, 27½ in. wide, and four 6¼ in. by 6¼ in. by 0.67 in. angle-bars, disposed at the corner to form a box section. It had a buckling load of 14 tons per sq. in., or 80 per cent. of the value given by Tetmajer's formula. The second column, 43 ft. 5 in. long, was built up of four flange-plates, 31½ in. by 0.57 in., and one web-plate of the same size, four connecting angles 4¼ in. by 4¼ in. by 0.55 in., and four angles at the edges 6¼ in. by 3½ in. by 0.525 in., connected to give an H-section in plan. This column collapsed at 13.7 tons per sq. in., or 89 per cent. of the value given by Tetmajer's formula. The author ascribes the unsatisfactory results obtained with the first column to (*a*) the difference of the elastic limit of the material used for the angles and that of the end-plates, on the one hand, and the vertical plates on the other (these are given as 25 and 20 tons per sq. in. respectively); (*b*) to the unsuitable arrangement of the diagonal lattice connection on the "open" side of the box-type column.

Mathematical proof of the author's contention is given, and it is shown that when the load on the column had reached 1,761 tons, the strain at the outer edge of the second diagonal and at the inner edge of the third had already passed the elastic limit. On continuing the test the main angle to which these two diagonals were connected collapsed. The author concludes also, from the test of the second column, that materials of different qualities were employed. He emphasises the necessity of making sure, in the design of built-up columns, that the possibility of local deflection of the individual supporting members is avoided. In connecting the angles of a column the use of full plates is to be preferred to the employment of lattice or trellis bracing. If the latter be used, horizontal connecting bars must be introduced at every joint. The article is followed by comment by Professor Rudeloff. — GRUNING ("Bauing").

The recent articles on the Ford foundry extension, which were extracted from the publications of the Penton Publishing Company, were written by Mr. Dwyer, who is a Canadian foundryman of considerable prominence attached to the editorial staff of "The Foundry."

* Institution of Civil Engineers, Foreign Abstracts.

The Determination of Bismuth in Brass.

32 grams of brass are dissolved in 250 c.c.s. of HNO_3 (s.g. 1.2). The excess of acid is evaporated off and the solution diluted with hot water to about 500 c.c.s.; 10 c.c.s. of HCl (s.g. 1.1) are then added. The solution is boiled, and a saturated solution of sodium carbonate added until a faint permanent precipitate is obtained; 1 c.c. of Na_2CO_3 is then added in excess. The solution is boiled for ten minutes, and allowed to stand until clear. The precipitate is filtered off and dissolved in the least possible quantity of hot HCl (s.g. 1.1) into the original beaker. A slight permanent precipitate is obtained with NH_4OH (s.g. 0.96), and the solution made just acid with dilute HCl (1 in 5), using methyl orange as indicator. The solution is diluted to about 500 c.c.s. with water, boiled for five minutes, and allowed to stand for one hour. If an appreciable amount of iron is present it is necessary to filter off the precipitate of $BiOCl_3$ and iron and redissolve in HCl (s.g. 1.1) It is again treated with ammonia and HCl (1 in 5) in the presence of methyl orange. The $BiOCl_3$ is filtered off, washed well with water, and dissolved by H_2SO_4 (s.g. 1.27) into a small beaker. A few crystals of sodium bisulphate are added to reduce the iron. When complete, the solution is made up to 100 c.c.s.

Colorimetric Estimation.—25 c.c.s. of this solution are placed in a Nessler tube, together with 5 c.c.s. H_2SO_4 (s.g. 1.27) and 5 c.c.s. of a 10 per cent. solution of KI; 5 c.c.s. of H_2SO_4 (s.g. 1.27) and 5 c.c.s. of KI are placed into another Nessler tube, and both solutions are diluted to about 50 c.c.s. A standard solution of bismuth, containing .0002 grains Bi per c.c., is run into the second Nessler tube until the intensities of colour are the same in each tube.

Alternate Method.—13 grams are precipitated with Na_2CO_3, dissolved and diluted as above. The precipitate of oxychloride is filtered off, washed, dissolved in HCl, and H_2S passed. The washed precipitate (after filtering) is placed in a small beaker, 10 c.c.s. of ammonia (1 in 4) are added, and H_2S passed through the solution. The precipitate is filtered off. dissolved in 10 c.c.s. HNO_3 (s.g. 1.2), and the excess of acid is boiled off. Ammonium carbonate and ammonia are added. The precipitate is filtered off, washed well, dried and ignited as Bi_2O_3.

Factor to bismuth = 0.8963. F. A. L.

Nickel Silver from Electric Furnaces.

"Electric Furnace Melting of Nickel Silver" was the subject of a Paper by Dr. F. C. Thompson, professor at Manchester University, at the annual meeting of the American Electro-Chemical Society. It was abstracted by Dr. Richards and presented the advantages of the externally-heated electric furnace for nickel silver melting as covering a reduction in the loss of zinc to less than 1 per cent., a minimising of the occlusion of gases, and a tougher alloy owing to less carburisation.

The Life of Dies.—Mr. P. O. Penrose, of the London Die Casting Foundry, in a letter to "The Engineer," states that in some cases we have made as many as 10,000 castings from one die, and we find that brass die castings can be produced commercially, provided the saving in machining is sufficient to cover the upkeep of dies.

Iron Inserts in Brass Castings.—A writer in the *Brass World* suggests that iron inserts will not blow provided they are heated before they are laid in the moulds. In the case of small work the moulds must be left open until ready to pour, then they must be cored with the inserts, but the latter while being hot, must not be red hot, otherwise they will oxidise on the surface with the result the brass will be very likely to blow-off the iron oxide, due to a reaction between the two. The iron inserts will blow if they are not free of oxide, even if they are hot; all oxide and scale must be removed, even if it is necessary to pickle the inserts in acids to remove the scale. They will blow if cold, because the moisture of the mould condenses on the cold iron, and they will blow if oxidised even if warm, therefore the iron must be clean and heated to a temperature above 100 deg. C., and no blowing can occur.

Institution of British Foundrymen.

Some Notes on Electron Metal.

LANCASHIRE BRANCH.

At a meeting of the Lancaster Branch, held on November 5, Mr. W. H. Meadowcroft, Branch-President, in the chair, Mr. J. D. Paton read a Paper on "The New White-Metal Series," with special reference to magnesium.

In the course of his preliminary remarks, Mr. Paton said:—

Lancashire would be among the first to benefit by the discovery and application of new materials, or of new methods of using materials to meet the new conditions in industry. With coal at high prices, driving and transport charges became serious; therefore transport lorries and textile machines were the first items for consideration. It would help them to appreciate the importance of magnesium if they realised how great the proportion of it was in the world's crust, as shown by the following figures:—Oxygen, 47 per cent.; silicon, 27 per cent.; aluminium, 7.8 per cent.; iron, 5.46 per cent.; magnesium, 2.68 per cent.; and carbon, 0.22 per cent.

It was not necessary to point out how extensively coal and iron were used in industry. Yet the percentage of the former (as carbon) was only 0.22. Then in the comparison, with iron with its 5.46 per cent., it should be borne in mind that the weight ratios were, iron 6, aluminium 2, magnesium 1; in other words, magnesium was a sixth of the weight of iron. Therefore, to get the corresponding bulk the 2.68 must be multiplied by 6, giving 16.04. Before 1914 the world's consumption of aluminium was between 20,000 and 30,000 tons, of which Germany's share was approximately 6,000 tons. During the war Germany had to find a substitute for aluminium. Experience had already proved that magnesium would in part at least meet the requirements, and the developments which took place during the war resulted in the production of a satisfactory substitute for aluminium in quantities which were reported equivalent to the pre-war world consumption of aluminium.

Physical Properties.

Electron metal was actually recovered from magnesite, and was supplied in ingots to any weight desired, but the larger they were the longer the time taken to melt and the greater the gas consumption. For these reasons the standard size was two kilogrammes; each ingot could be broken into two one-kilo blocks. They were almost identical with aluminium ingots, but, size for size, were only half the weight.

In hardening magnesium a small proportion of aluminium was added. The 12 per cent. copper-aluminium alloy, when compared with the 2 per cent. aluminium-magnesium, showed that the alloy would be actually lighter than the pure metal ratio, by the out-of-balance increment in aluminium alloys. The magnesium alloy was 6 to 4 commercially and 4 to 6 when pure.

The characteristics of the new metal may be summarised thus:—Tensile strength (cast), 7 to 10 tons; tensile strength (rolled), 10 to 15 tons; heat expansion, 0.000027 per linear ft.; specific heat, 0.25; specific gravity, 1.74.

Casting Magnesium Metal.

The casting of electron metal must be carried out with care. A certain amount of experience of the nature of the metal, its physical and mechanical characteristics, was necessary, but a skilled workman readily acquired this experience and was then capable of producing serviceable castings. The burning of magnesium is a well known property. In melting magnesium in a furnace much the same thing happened—intense heat was generated, accompanied by a blue flame. There was some danger, but only when the metal was in a molten condition, and it could easily be guarded against if damp were absent.

If overheated the metal became plastic and had a tendency to absorb gases, therefore the moulds should be kept covered as far as possible, gas and coke fumes must be kept away from it, and it had to be watched and controlled carefully with a pyrometer.

The ratio of coke to metal was 500 lbs. of coke to 1,000 lbs. of metal, so the heat losses were not very high.

With magnesium in a hot state the presence of water meant liability to trouble, possibly a series of explosions. There must be no wet sand, and it was essential to have the floor dry. If men were walking about they must do so carefully and they must not draw a pot too hot; the temperature should be reasonably low, and the metal must not lap the lip of the crucible when drawn.

The moulds also must be as nearly as possible bone dry. They must not be constructed of any material which held water in a combined form or in a form which under the pressure and action of the metal would be distilled out as vapour and provide an explosion. For that reason the walls should be banked. A sand of high silicon content which did not contain water in its mechanical composition was essential.

It was necessary to have a series of gates running from and to the casting. The feeders were very thin. Apparently long crystals were formed on the outside, which acted as a sieve for the hot metal which washed through, the dross being held back.

When using as a base magnesium oxide, which was heavier than the metal, it was difficult to remove it. The advantage of magnesium oxide in other metals was that its weight was so much less than when used as a flux it was expelled. For that reason it was an excellent de-oxidiser, but no flux had been discovered that was capable of expelling the oxygen from the surface of the molten electron metal and at the same time be harmless to the metal. Magnesium chloride could exclude oxygen, but the objection was that the chloride entered the metal and set up disintegration.

Very often a sort of burning on the top of the mould was set up, and to remedy that a handful of dry sand was spread over the top.

In order to avoid oxidation, to get the metal away from the bottom and to get clean running, the author had tried bottom pouring, but what happened was that the drops dripping when shutting off the stream of metal had a tendency to ignite, with the result that the oxidised particles remained and accompanied the next flow into the mould. They appeared again as oxide, which would possibly spoil the casting.

The casting was knocked out reasonably quickly, but at a temperature not exceeding 100 deg. C., above which it was rather brittle.

The colour depended on the temperature of the metal and the dryness of the mould. Silver colour was obtained by casting at the correct temperature into a perfectly dry mould, the temperatures being 650 to 680 deg. C. for thick-walled castings, 700 to 750 deg. C. for thin-walled castings. Blue and silver colour was obtained when the metal was so hot that it affected the silicon of the sand, which entered the surface of the metal. When the temperature was correct but the sand mould was damp the colour was grey.

The Fettling of Electron Castings.

In the fettling shop the castings were whitened with a brush. The only danger arose from the dust. If that was set in motion there was a risk of explosion. The danger was guarded against by accumulating the dust in a box; if any local heating occurred they simply put a shovel of sand on it.

If carefully carried out, there was no danger in the operation of casting. With dry floors, careful handling, careful gating, and correct heating the castings would be produced without trouble. Every new metal had its development troubles. In its early stages aluminium was very liable to oxidation. If this new magnesium metal was treated with enamel there did not seem to be the same reaction between the enamel and the metal surface as there was with aluminium. With the latter there appeared to be crystals formed larger than the original aluminium surface dimensions, and the enamel was pushed off. As far as the author had been able to follow the reaction between the new metal and enamel, the trouble was not so extreme; therefore the lacquer or similar material was more or less permanent.

Some Uses of Electron Metal.

An enormous advantage of the metal was its ductility, especially in a cast form. Very often ordinary castings were brittle and could not be stamped after they were made, but it was possible to cast this metal as a block which could be put into a vice and stamped as hard as possible to get the desired compression. The skin could be case-hardened and such material would burnish. He submitted for inspection a specimen screw, pointing out that it was much better cut than one made of aluminium and had the further advantage that it could be machined at three times the speed of aluminium. The platen plates used in the weaving trade used to be made from brass, and the machining cost was high. They could now be made of magnesium metal and machined with an enormous saving in cost and at the same time produce a better article; while it was possible to get a sound plate in which there were several thousand holes, thus showing the capabilities of the metal. The applications of it were innumerable. In the electrical industry magnesium alloys could be used for fittings, brackets, busbars, connections—every form in which copper had been used and aluminium had been brought in as a substitute. It had been successfully applied in aeroplane work. It might be thought that where sparking was produced magnesium would be a bad metal, but the results had been satisfactory. An aeroplane constructed almost entirely of it was loaded with petrol, sent up as high as possible and then shot through so that it dropped in flames to the ground. But although magnesium was supposed to be an inflammable metal it was the last thing to burn in that test; the wood, the fibres, and everything else on that aeroplane were burning before it.

In regard to the textile machinery trade the author had been trying for many years to get structures made in the light metals, especially mule rim shafts weighing 3 cwts. to 5 cwts. In some mills there were 80 of these, and to bring them up to the speed required was a large load. The drop in weight, say from 6 or 5 cwts. to 2 or 1 cwt., through the substitution of the new metal for cast-iron had a material effect. If normally it took three seconds to accelerate a cast-iron rim shaft; it took only one second when the rim was made of the new metal.

The foundry had a contribution to make towards the solution of the transport problem. In order to get cheap and efficient transport on a low basis of cost, the lorries and other structures must be made as light as possible. A 5-ton gas lorry actually ran about 100 miles for a cost of 8s. It might be possible that through the use of this new material instead of having 3 cwts. or 4 cwts. of apparatus on the machine, to reduce the weight to 1 or 1¼ cwts., thus lowering the initial cost of the lorry and possibly be able to reach a running cost of 2s. per 100 miles when gas fuel could be based on reasonable coal costs, say 20s. to 30s. per ton.

THE DISCUSSION.

During the discussion, which was of a conversational nature, much interesting information was given by the lecturer. Amongst other facts elicited were that the cost of the virgin metal was 2s. 6d. and equivalent to brass at 5d. Magnesium alloys were moulded in sand, chill-moulding being unsuitable. There appeared to be some reaction between the iron and the mould, resulting in a little understood blowing effect. Magnesium was particularly suitable for alloying with the lead series, being used to harden them, as for instance heavy copper cables with lead sheathing. It was very difficult to get such lead homogeneous so as to keep out water, but with a slight addition of this metal nearly twice the strength was obtained associated with less reaction and corrosion. It would also harden the tin series, but it was little used for that purpose.

Replying to a question as to whether magnesium attacked iron crucibles similarly to aluminium, the author stated that there seemed to be little reaction between the iron and the hot metal.

Another interesting fact which was elicited was that the melting loss had been reduced from 10 per cent. to 5 or 6 per cent.

MR. W. H. COOK, taking up this point, said in his experience none of the light metals gave so small a loss. Commercially, 10 per cent. was satisfactory, as in some foundries it rose to 30 per cent.

MR. CARTER explained that if this metal was used for textile machinery there would be much planing and turning. Was there any method of using the swarf?

MR. PATON said the best method was to briquette the material and put it into a liquid bath. When a scum appeared on the top various salts should be continuously added. No reaction took place, the dross simply sinking to the bottom.

The lecturer, replying to a question as to the advisability of using scrap material for re-melting, stated that it was desirable to refine the scrap before it was put into the ingot moulds. Such a method had reduced rejects to 2 per cent. Sand being left on the castings when they were returned to the pot increased the rejects to 7 per cent. in the first month, 15 per cent. the next month, and after that 25 per cent. Trouble from porosity in re-melted metal arose from scabbing by reason of the presence of silicon or sulphur or some other impurity. If a light substance, such as magnesium, could be attached to that ingredient it floated and was brought up to the top of the bath.

Almost the same tensile strength as that given by aluminium was obtained in ordinary work. In test-bars aluminium went as high as 15 tons, but the "electron" metal was not of the same weight; so if a 7 to 8 tons guarantee was given, it was virtually the aluminium ratio. But in one respect there was an important difference. Whilst aluminium would not withstand alkalies, it would withstand acids. Magnesium, however, would withstand alkalies but not acids. The two metals were therefore complementary. In the soda trade, where alkali was used, one could make vessels of magnesium where they could not be made of aluminium. In the weak acid trades—for instance, for brewing and fermentation processes—aluminium was ideal.

Aluminium alloys are more stable than other alloys. A 6 per cent. copper-aluminium, for example, being especially so. Electron is in its first stages, and it has more or less to prove itself. It was the same with aluminium, for at one time it was considered impossible to use aluminium for copper apparatus or trolley shoes for railway work. But now this metal can be case-hardened and burnished like copper and gave a durable hard surface.

The Malleability of Magnesium.

Electron was the most malleable metal yet made. It could be hammered, moulded, and shaped as desired. A new system of dry pressure-welding (Heraeus) was coming into use. By this method the material was put into place, the edges being together, and then hammered. It was just possible that the impact of the hammering closed the surface, or perhaps some electrical effect was combined in the action of the metal. It could be soldered with blended solder the same as aluminium.

Magnesium Chills.

Moulds for die casting were still under test. Die casting was entirely a functional relation between the metal that was going into the mould and the metal of which the mould was composed. In every metal that was not stable or permanent there was a continuous extrusion from the body of the metal to the outside. If in its constitution there was what he called an unbalanced element—that is an element which was not in rest—such material came to the outside. It might happen that the extruded material passed into the body of the casting. The extrusion then took place from the die to the casting. On the other hand, the extrusion might be from the casting to the die. Then the die was becoming smaller in size. The proposition was to have the die material of such a nature that they obtained the proper relation between it and the metal that was poured in; otherwise the former would become eroded and useless.

In conclusion, the author hoped eventually to produce a magnesium steel. There was a law of evolution in these things, and being optimistic he believed that in a little while they would move towards a combination of magnesium with iron and get a light steel for the future use of man.

The meeting closed with a vote of thanks to the lecturer.

British Industries' Fair, Birmingham.

Notwithstanding the adverse national and international commercial and industrial conditions which continue to exist, the interest which is being shown in the forthcoming British Industries Fair (Birmingham), which will be held at Castle Bromwich from February 27 to March 10, 1922, is very gratifying to the Fair authorities, and they have every confidence that the successes of the two previous Fairs will be repeated. If this result be achieved it will be a remarkable testimony to the foresight and the enterprise of the manufacturers of the country. To those who hesitate, the advice might well be offered that in times of good trade it is desirable for business houses to keep their goods before the world, and thus retain the goodwill which they have already acquired, and that in times of trade depression it is seriously detrimental for them to cease to advertise or exhibit, pending the return of prosperity, because then they would be a day after the Fair, and their more enterprising competitors would have a great advantage over them.

For very many years the attitude of Governments towards trade has been one of *laissez-faire*, but the war has brought about a number of changes, not the least of which is that created by the Trade Facilities Act, 1921, which was passed into law on November 10, and which has given unprecedented interest to the forthcoming British Industries Fair. As is well known, the Overseas Trade (Credits and Insurance) Act, 1920, was not effective because of its many restrictive provisions, and consequently very few trades could see their way to apply for credit or insurance under its provision. The Trade Facilities Act, 1921, embodying as it does provisions long recommended by the Association of British Chambers of Commerce, marks a distinct advance, firstly, because its provisions are more business-like, and, secondly, because it applies to business transactions in all parts of the world except Russia and India—the former for obvious reasons, and the latter because the bankers declare that they are able and willing to grant any financial assistance or credit required by Indian merchants.

Under the new law, credits are divided into two sections. One of these, Section (A), has been designed to facilitate the purchase of goods from British travellers in overseas countries. Under the old export credits scheme it was necessary to make a separate application for each transaction requiring credit. This prevented travellers from clinching sales on the spot, and frequently ended in the sale being lost entirely. That difficulty has now been completely removed. Under Section (A) the British manufacturers can obtain credit up to an amount sufficient to cover a number of transactions. There is no need to make separate applications for each transaction. Goods can thus be bought from British travellers without any further reference to the Export Credits Department.

The other Section (B) is designed to deal with only one transaction at a time. As in the case of Section (A) the British Government will grant credit up to 100 per cent. of the amount of a transaction as recorded by the invoice tendered to the buyer where the term of credit does not extend over twelve months. Where longer terms of credit are wanted, the Government grant 85 per cent. of the total amount of the Bill of Exchange drawn against the shipment. A point worth noting is that the credit can be granted to exporters independently of whether the buyer puts up security.

Terms of credit such as these should be of incalculable value to overseas buyers at the British Industries Fair. A bureau will be established at the Fair by the Export Credits Department of the Department of Overseas Trade. Thus overseas buyers can, under one roof, inspect the best of all classes of British goods, and if agreements to purchase are likely to be made the exhibitors can arrange liberal terms of credit in view of the assistance provided for under the Trade Facilities Act, the sole object of which is to facilitate the resumption of the ordinary means whereby traders and others can obtain facilities from their bankers to enable them to finance their export trade.

NOTES FROM THE BRANCHES.

Birmingham Branch.

It has been decided to change the lecture programme of the Branch, which now reads:—December 10, "Some Perplexing Foundry Problems," J. Shaw (Sheffield); and January 14, "The History of Cast Iron," J. Newton Friend, Ph.D., F.I.C.

London Branch.

About forty members visited the works of Messrs. Lake & Elliott, Limited, of Braintree, on November 26. After tea, which was provided by the firm, the party were conducted over the works by the directors and staff. The excellent lay-out was thoroughly explained. Modern electric furnaces which provide the steel, a novel and efficient sand-preparing plant, and a reliable system of inspection of the finished castings were the outstanding features of the plant. These features were much appreciated by the visitors.

New Branch at Bradford.

A meeting was held last Wednesday in the Lecture Hall of the Bradford Technical College for the purpose of forming a Branch of the Institution of British Foundrymen to cover the Yorkshire district. The meeting was presided over by Mr. Oliver Stubbs, President of the Institution, and he was supported by Mr. J. Hogg, President of the Burnley section of the Lancashire Branch, Mr. R. Carrick, of Shipley, and Mr. A. Love, of Bradford.

There was a very good attendance of employers, foundry managers, foremen and moulders from the Yorkshire districts, and as a result it was unanimously decided to form a "*West Ridings of Yorkshire Branch*," taking Bradford as the centre, and comprising Bradford, Leeds, Huddersfield, Keighley, Halifax, Shipley and Wakefield.

The question of the election of the first president was deferred until the next meeting. A temporary Committee was appointed, along with Mr. T. Johnson, 32, Wensley Dale Road, Bradford, as acting secretary.

Between 50 and 60 promises of membership were announced at the meeting.

Any further information respecting the Branch may be obtained from the Acting Secretary.

Iron Smelting in Nelson Province of New Zealand.

His Majesty's Trade Commisioner in New Zealand has informed the Department of Overseas Trade that a blast furnace has been erected by the Onakaka Iron and Steel Company, a company formed in 1920 to manufacture iron and steel from the limonite iron ore found in the Onakaka (Nelson Province) district of New Zealand. Coke, ore and limestone are to be raised to the top of the furnace by hydraulic lift, and sixteen beehive coke-ovens are being built close by. The company anticipate that the industry will eventually employ some hundreds of men, and that the output of the plant will be 30 tons per day. New Zealand's requirements of foundry iron are said to be in the neighbourhood of 15,000 tons per annum, so that the company will not be able to supply the full requirements of the Dominion.

British Empire Exhibition (1923).—The Executive Council of the British Empire Exhibition announce five or more Commercial Research Fellowships for competition among Chambers of Commerce in the United Kingdom. The value of each Fellowship will be not less than £500, and will include a first-class return ticket to the Dominion, Crown Colony, etc., to which the Fellow will proceed. The subjects of research will be as follows:—(1) The best means of promoting inter-Imperial trade in a selected staple industry. (2) The methods whereby the British Empire Exhibition can further the interests of this trade. (3) The potential resources in raw materials, etc., in the Dominion or Crown Colony visited, and the best means for exploiting these in the mutual interest of the Dominion and this country. (4) The means whereby these undeveloped resources may be adequately represented at the British Empire Exhibition and brought to the attention of interested financial or industrial groups. For conditions of election and further particulars, apply to the Secretary, British Empire Exhibition (1923), Incorporated, 16, Hobart Place, London, S.W.1.

XUM

A Discussion on Foundry Costs and Establishment Charges.

At a meeting of the Manchester Association of Engineers, held on November 25, Mr. J. H. Stubbs in the chair, Mr. D. Adamson read some notes upon foundry costs and establishment charges, which were printed on page 437 of the last issue of THE FOUNDRY TRADE JOURNAL.

In opening the discussion, MR. J. BUTTERWORTH said the foundry branch of the engineering industry was the most ancient, its origin going back to pre-historical times, but it was perhaps the most backward in book-keeping methods. Conditions had changed somewhat in recent years, and they were pleasanter now than in the early 'eighties. Every foundry had a different class of work, and in costing it should be divided up in two ways, so that one system of charging would check the other. Material should be allocated to the different departments—plate and machine moulding, bench work, etc—and, according to the size and the labour expended on each, the foreman or manager should allocate a proportion of the standing charges for power, light, etc. Or there could be a department for metals and materials such as coke and limestone, etc. The sand department was common to coremaking and moulding; it should be taken as a watertight compartment.

Limitations in Costings.

MR. W. H. COOK asked what hope engineers could have of cheap production if they did not get good sound castings. Bad castings entailed enormous loss when they were not discovered, particularly in brass work, until they had reached the last process before being polished and delivered to the customer. It was not possible to draw definite lines of division between light and medium and heavy castings. In one foundry the weight varied from a few ounces to hundredweights, in another from a hundredweight to a few tons. Neither was it possible to allocate fixed charges on the basis of the cost of skilled labour. In the example given by Mr. Adamson the cost of power was divided in the proportion of 25 per cent. to metals and 75 per cent. to workmanship account. But a particular foundry might provide no power for the workmen except a crane; the castings might be so heavy that no rattlers were used. How could 50 per cent. be put on there? It was suggested that light castings cost more than heavy castings. That might be so in some cases, but not in all. He advised that cores should be done away with as much as possible; a draughtsman who understood his business would help in that and there would be a reduction in bad castings as well as a saving in cost. A 12½ per cent. loss in melting, as estimated by Mr. Adamson, would be ruinous. In his own foundry if the figure exceeded 5 per cent. there was an inquiry, but he observed in one of their records the actual figure was 4.07 per cent.

MR. COOK exhibited a document which showed the manner in which his firm kept their records, and pointed out that they took the cost of the metal as it ran from the spout. Such bad castings as were made were returned to the foundry. He added that in mixing scrap and pig they did not adhere to any fixed formula, the proportions varied according to the quality of the scrap. A system of costing should not be carried too far, the expense might outweigh any saving that could be made.

Melting Losses.

MR. G. KAY, speaking with 40 years' experience of foundry work, stated that for some years while in India he weighed all the metal that went into the furnace. The loss on melting was something like 15 per cent.

MR. HARPER remarked that Mr. Cook's figure for melting losses was exceptionally low. In costing the first step was to arrive at the cost of the molten iron. Then the labour account. There were bound to be variations in the percentage of overhead charges, but they could be taken over a period of three months. Adding that to the other items they arrived at a net cost of production which wanted a lot of upsetting.

Allocation of Losses.

MR. BERRY said to work out what was spent in materials and labour and then divide the amount by the weight of castings produced might be very misleading; they really wanted to know what each particular class of work would cost to see whether the foundry was working at a profit or a loss upon them. The loss on bad castings should not be charged against the whole output, but upon the particular class. With some there would not be one bad casting in a thousand, but in other classes the figures were surprisingly large.

The Subdivision of Costs.

MR. BENTHAM said castings varied enormously, and on a particular method of costing might be perfectly suitable in one case but inapplicable in another. A short time ago he came across a contract in which the average price was 55s., but the cost of the individual articles ranged from 35s. to 125s. The question how far it was worth while to go in subdividing was a very open one, and it seemed to him that all "on-costs" were approximations. Mr. Adamson suggested dividing the year into thirteen periods of four weeks. In their own method they did it weekly. Certain items, such as income-tax, depreciation, etc., were taken yearly, but divided by 52, giving them the weekly cost. Theoretically, fettling should be charged to the job, but it was difficult to work out as a direct charge, and he had not been able to do so. Material and labour were more serious items than the on-costs, but they were more easily controlled, and it was perhaps in that direction that they should look for economies.

Raw Material Costs Variations.

How would Mr. Adamson deal with variations in prices of materials? Six months ago they bought pig-iron at £14 per ton and some of it was still in stock, but the price had gone down to about £8 per ton. What should be put down as the cost? That factor would vary very rapidly. With regard to melting losses, he thought the speakers who had referred to that question did not all mean the same thing. In their own case, taking as the basis the castings turned out of the foundry, the net loss was 10 per cent., but taking it on the basis of the metal melted in the cupola it was about 6 per cent.; it showed that a large amount of scrap was made in the foundry and returned to the cupola. The figure for coke was about 300 lbs. per ton. More could be saved by improvements in designing and doing away with cores than by almost any other factor. Hitherto that had been neglected in English foundries, which were behind those in other countries, and there was need for improvement which would make them more attractive to workmen and lower the cost of production.

MR. FIELDEN said, for estimating purposes they should begin with the cost of the molten metal in the ladle, then take the moulders' time as booked, and add a proportion of the standing charges.

The Author's Reply.

In replying, Mr. Adamson suggested that more attention was now given to the foundry department because it was not so profitable as formerly, and people were trying to find out how it could be more efficiently worked. Apparently the various speakers agreed that one should take the cost of the metal in the ladle, but when they came to the distribution of the established charges there was a good deal of room for the exercise of individual judgment. It was for each to decide what was the most suitable method for his particular case.

Iron Ore in the Malay Peninsula.

Mr. H. Marriott, General Adviser to the Government of Johore, reports the opening of an iron mine on the left bank of the Batu Pahat River, a mining certificate over 50 acres having been issued to a Japanese. The ore is mainly hematite, containing about 65 per cent. of iron, and there is sufficient ore in sight for five years' working.

This deposit of ore is being actively worked, and the monthly output is now 8,500 tons of excellent quality. The ore is being shipped to Japan. It is reported officially that similar deposits are known to exist in Johore and other parts of the Malay Peninsula.

Trade Talk.

DAVIS TURNBULL & COMPANY, LIMITED, have removed to Prudential Buildings, Sheffield.

TAYLOR BROS. & COMPANY, LIMITED, of Leeds, are transferring their business to Manchester.

WM. WHITWELL & SONS, LIMITED, are making preparations for re-starting two furnaces at Thornaby.

THE WEEKLY MEETING of the London Iron and Steel Exchange will in future be held at the London Metal Exchange.

MR. J. NEWTON FRIEND lectured before the members of the Birmingham Metallurgical Society, on Nov. 25, on "Metal Corrosion."

THE FIRST unit of the plant at Risdon, Tasmania, of the Electrolytic Zinc Company of Australasia started running on November 22.

THE SCUNTHORPE blastfurnacemen have decided to accept the terms offered by the ironmasters, viz., to anticipate a reduction in the sliding scale.

BARNES & BELL, LIMITED, 79, St. George's Place, Glasgow, have been appointed sole Scottish agents for the Diamond Coal Cutter Company, Wakefield.

THE Penwyllt Dinas Silica Brick Works have been amalgamated with the Amalgamated Dinas Silica Works, Limited, 1, Northampton Place, Swansea.

MESSRS. THOMAS S. SMEETH, of Tyrrel Street, Bradford, have been appointed sole agents for Yorkshire and Lincolnshire for the Dalmellington Iron Company, Limited.

SIR ARTHUR F. PEASE has formally opened the New Pease Club, Southfield Road, Middlesbrough, which Pease and Partners, Limited, have erected for the benefit of their employés.

THE BASIC open-hearth process of steel manufacture was the subject of a Paper recently read to the Sheffield Association of Metallurgists and Metallurgical Chemists by Mr. J. N. Kilby.

ON THE GROUND that the wages offered were not high enough, the employés of the English Crown Spelter Works, Swansea, have refused the employers' terms for the reopening of the works.

MESSRS. P. & W. ANDERSON, LIMITED, 199, Piccadilly, London, W.1, have obtained the contract for the new iron foundry at Norton, near Malton, Yorkshire, for the United Foundry Company, Limited.

Two furnaces are to be relighted at Redbourne Hill, with another to follow later at Frodingham. As regards Redbourne Mr. Frank Thomas is devoting much personal attention to the works at the present time.

AT THE MAPPIN HALL, Sheffield, recently, Professor R. V. Wheeler, of the University staff, addressed a large number of members of the Sheffield Society of Engineers and Metallurgists on "Gas Producer Practice."

LINDSAY, CROOKSTON & COMPANY, LIMITED, 191, West George Street, Glasgow, at present agents for Baldwins, Limited, have been appointed agents for the Port Talbot Steel Company, Limited, which is a subsidiary company of Messrs. Baldwins.

ENGINEERS AT BARROW-IN-FURNESS are opposing the provisional agreement between the Amalgamated Engineering Union and the Employers' Federation, under which the management have the right to decide when overtime is necessary, and are demanding that the union shall call a national conference.

WE understand that the Wellman Smith Owen Engineering Corporation, Limited, of London and Darlaston, have secured a contract from the Barrow Hematite Steel Company, Limited, Barrow-in-Furness, for the crane equipment of their new steelworks extension, including ladle crane charging machine, etc.

A CLYDESIDE REPORT states that recently a number of the furnaces at Wm. Beardmore & Company's Mossend Steel Works were rekindled, and it is learned that work will be resumed there forthwith on a partial scale. The renewal of operations, even on a partial scale, is regarded as promising. Almost 1,000 men are affected.

CAST-IRON pipes have been so considerably reduced in price (being less than one-half of what they were twelve months ago) public bodies are now in a position to resume mainlaying. The Leicester Corporation, for instance, have recently placed an order with the Staveley Coal and Iron Company, Limited, of Chesterfield, for 2,700 tons of 27-inch pipes.

LICENCES under the Non-Ferrous Metal Industry Act, 1918, have been granted by the Board of Trade to Hurley, J. A. E., Helena Street Parade, Birmingham; Malmberg, K. A., 110, Cannon Street, London, E.C.4; Melville, H. D., trading as Melville and Company, 65, Fenchurch Street, London, E.C.3; Wright, Bindley and Gell, Limited, Percy Road, Greet, Birmingham.

MESSRS. J. C. Bishop and O. Coyle, joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, have been informed by the accountant that he has examined the employers' books for September and October, and certifies the average net selling price brought out to be £15 10s. 2.17d. This means a decrease in the wages of the workmen of 15 per cent. on basis rates.

MR. DOOLEY, the Premier of New South Wales, states that the closing down of portions of the Newcastle steel works and the consequent dismissal of between three and four hundred employés are due to the action of the Commonwealth Government in "allowing the unrestricted inflow of German steel disguised as the manufacture of another country, and thus crippling the Australian industry."

MESSRS. HADFIELDS, LIMITED, the well-known steel manufacturers, of Sheffield, have joined the ranks of Australian manufacturers. This company has associated itself with the Australian Electrical Steel Company, Limited, of Alexandria, Sydney, which is being re-formed with a capital of £500,000. Sir Robert A. Hadfield, the head of the parent company, will be on the directorate of the new Australian company.

HIS MAJESTY'S TRADE COMMISSIONER at Toronto (Mr. F. W. Field) reports that a local company are desirous of receiving quotations from United Kingdom manufacturers of lifting jacks of various types similar to those manufactured by an American company. The name and address of the Toronto company may be obtained on application to the Department of Overseas Trade, Room 50a, 35, Old Queen Street, London, S.W.1.

THE MONOMETER MANUFACTURING COMPANY (1918), LIMITED, are supplying their temperature-controlled melting furnaces to Metropolitan-Vickers Electrical Company, Limited, Leeds Corporation, Southend Corporation, Northern Press Engineering Company, Temple Press, Limited, Binger (Amsterdam), Vieyra (Paris), and Bossong (Zurich). Other orders are for hardening and annealing furnaces, lead melting furnaces, and die-casting plants.

SOME ACTIVITY is now noticeable in the building trade in Alexandria, particularly in the erection of private villas in the suburbs, states His Majesty's Commercial Agent for Egypt. United Kingdom firms desirous of offering supplies of building materials can obtain the names of contractors and importers of such materials in Egypt on application to the Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1. (Ref 6450/FE/P.N.)

MESSRS. J. R. WINPENNY & W. T. GRIFFITHS, the joint secretaries of the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England, have issued Messrs. Price, Waterhouse & Co.'s report for the two months ending October 31, which shows an average net selling price of £15 13s. 6.84d. On this figure the sliding scale gives a reduction of 10 per cent. on puddling and other forge and mill wages, to take effect from November 28.

"ORNAMENTAL CASTING" was the title of a paper prepared by Mr. J. H. Taylor and read by Mr. A. Jefferson to the members of the Sheffield Silver Trade Technical Society, at the Mappin Hall recently. The paper contained a review of the production of smooth sound castings, and each section was carefully dealt with, including moulding sands for facing work, fine work, and cored work. A few of the many problems which confront the caster were also carefully examined, and at the close an interesting discussion took place.

THE ABOLITION of the 8s. a day minimum, and the reduction of wages by the dropping of the 5½ per cent. increase granted some six weeks ago, were the proposals made by the employers at a joint meeting of the Cleveland ironstone mineowners and miners' representatives, held at Middlesbrough on the 28th ult. The miners' representatives resisted the claims, but it was finally decided that the 8s. minimum should cease at the end of the present week. It was agreed that the 5½ per cent. should continue until January, when wage rates will again be discussed.

THE CLYDE shipbuilding returns for November show that the launches on the river comprised only seven vessels, of 15,580 tons. With the exception of January, this is the lowest monthly total recorded in 1921, and it compares very poorly with the highest, 25 vessels of 82,431 tons, launched in February. It is also the record lowest output for November for many years back, and much below the average for the month. For the eleven months, the Clyde output consists of 202 vessels of 421,450 tons, which is lower by 143,243 tons than that of the corresponding period of last year, and by 206,971 tons than that of the best corresponding period, which was that of 1913, when 238 vessels of 628,815 tons were launched

AT THE James Watt Anniversary Dinner of the Institution of Engineers and Shipbuilders in Scotland, held recently at Glasgow, Mr. H. E. Yarrow, the president, was in the chair, and those present included Sir James Watson Stewart, Bart., Sir John Ure Primrose, Bart., Sir Halford J. Mackinder, M.P., Sir William Sutherland, M.P., Sir Alexander Gracie, Mr. Summers Hunter, Sir John Lindsay, Sir Robert Bruce, Sir John Hunter, Sir Thomas Bell, Mr. G. A. Mitchell, Sir Alexander M. Kennedy, Mr. Hugh Reid, Sir James MacKechnie, Sir John S. Samuel, Sir John Dewrance, Mr. Archibald Shearer, Sir James H. Kemnal, Mr. Robert Traill, Mr. Andrew Gray, Mr. John M. Gilchrist, Mr. R. W. Dana, Mr. S. Mavor, and Professor Magnus MacLean.

XUM

A Simple Charging Apparatus for Siemens and other Metallurgical Furnaces.

We illustrate a simple charging device which has been evolved by Mr. N. H. Bacon, Lydgate Lane, Sheffield, for expediting the work in the hand-charged melting shop. Briefly, it consists of a bar which is provided with a hand wheel at one end and at the other with means for attachment to the charging pan, upon this bar being mounted two ball rings or runner blocks with hooks attached. The upper hook is suspended by chain from the crane or overhead girder placed above and in front of the charging door, the

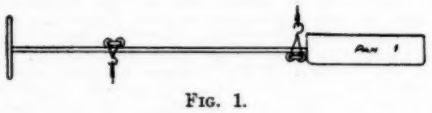

FIG. 1.

lower hook, during charging operations, being attached to a roller hook which travels on a runway along the furnace platform parallel with the furnace front.

The method of application is as follows:—In the position Fig. 1, with the pan empty, the whole apparatus is balanced. The leverage is over 3 to 1, so with 10 cwt of material in the pan two or three men can readily balance it and push it into position. (Fig. 2.) The second roller sheave is then attached to the staging, and the apparatus hangs balanced between the two roller sheaves. It only remains to push the bar along through the rollers, and swing the pan round to between the doors. This is readily done as the hook in the stage to which the second roller sheave is attached runs along parallel with the furnace front.

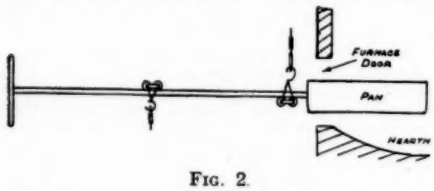

FIG. 2.

By turning the handle the pan is turned over and its contents emptied on to the furnace hearth. The pan is then withdrawn, detached from charging bar, and another full pan attached.

Whilst a crane of some sort is an advantage when using this apparatus, it can readily be used without one. In this case the apparatus is suspended from a swing girder pivoted over the middle door of the furnace. (Fig. 3.) This should be of great value in machine-charged shops, in which a good proportion of the working time of the charging machines is occupied in feeding the furnaces, during which periods the charging of a neighbouring furnace is necessarily neglected.

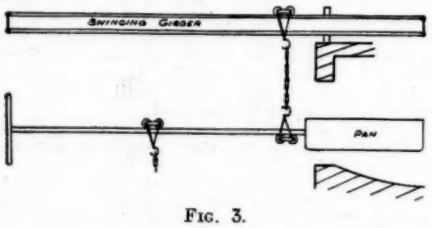

FIG. 3.

The auxiliary apparatus for putting in the feed would not in any way interfere with the passage of the charging machines. Also as the stage area in a machine-charged shop is usually large, the size of the charging bar could be increased, enabling bigger loads than 10 cwt. to be handled at one operation.

The Bacon apparatus to meet the conditions of the works comprises, for one stage (actual sizes and approximate weights): Charging pan, 6 ft. × 1½ ft. × 1½ ft. = 5 cwt.; charging bar, 10 ft. × 4½ in. outside dia., 2 in. inside, fitted with 4-ft. wheel at one end, an attachment for securing pan at other end, and mounted with 2 loose roller sheaves, 5 cwt.; material charged each operation, 10 cwt.; total, 20 cwt.

THE LATE Mr. H. Hope, a director of Henry Hope & Sons, Limited, Halford Works, Smethwick, left property of the value of £13,642 gross and £13,465 net.

Company News.

Beecroft & Partners, Limited. — Capital £1,000. Dealers in ferrous and non-ferrous metals, etc. F. J. Beecroft first director. Registered office: Norfolk House, 36, Cannon Street, Birmingham.

Blue Bird Engineering Company (Liverpool), Limited.—Capital £1,000. Registered office: 122, Everton Road, Everton, Liverpool.

Components, Limited.—Dividend, 5 per cent. for year, less tax.

Coventry Simplex Engines (1921), Limited.—Capital £5,000. Directors: C. W. Wardle (managing director), and G. Wardle.

Craigie Engineering Company, Limited. — Capital £1,500. Registered office: 26, Elmbank Street, Glasgow.

C.V., Limited.—Capital £5,000 in £1 shares (4,750 A. and 250 B.). Metallurgical Chemists. Secretary: H. C. Hawkins. Registered office: 20, Copthall Avenue, E.C.

Delstar Engineering Company, Limited. — Capital £1,000 in £1 shares. Mechanical and electrical engineers, etc. Directors: H. Creighton and A. Blair. Secretary: E. Creighton. Registered office: 100, Woodhouse Street, Leeds.

B. Firman & Company, Limited.—Capital £5,000 in £1 shares. Engineers. Registered office: 12, Low Pavement, Nottingham.

A. Pank & Son, Limited.—Capital £10,000 in £1 shares. Agricultural and general engineers, etc. Directors: A. Pank and A. R. Pank. Secretary: A. W. Sales. Registered office: 8-12, Bedford Street, Norwich.

North Lonsdale Iron & Steel Company, Limited. — Final dividend, 3½ per cent., making 6 per cent. for year.

Pring & St. Hill, Limited. — Capital £15,000. Mechanical and constructional engineers and founders. Directors: G. C. Pring, A. St. Hill, and L. T. Pring (all permanent).

Railgrip Syndicate, Limited.—Capital £10,000 in £1 shares. Manufacturers of rail grip wheels. Registered office: 10, Basinghall Street, E.C.2.

Royd Machine & Tool Company, Limited.—Capital £1,500 in £1 shares. Directors: E. Gregory, H. Hayes, W. H. Chapman, and H. Aykroyd.

Shotts Iron Company, Limited.—Brought in, £59,990; debit of profit and loss account, £331; preference dividend for half-year, 2½ per cent.; carry forward, £57,634.

Temple Cox Research Company, Limited.—Capital £20,000 in £1 shares (10,000 cumulative preference). Research work, smelters, founders, etc. Directors: R. Temple, E. R. Jones and P. Cox. Registered office: Dacre House, Dean Farrar Street, Victoria Street, S.W.1.

Union Electric Welding Company (Egypt), Limited. —Capital £10,000.

United States Steel Corporation.—Quarterly dividend, 1¾ per cent. on preferred stock, payable on November 29.

Wintersgill & Worth, Limited. — Capital £500. Mechanical, electrical, and petrol engine engineers, etc. Directors: G. Wintersgill and W. M. Worth.

Zodiac Engineering Company, Limited. — Capital £1,040, in 500 A ordinary and 500 founders' shares of £1 and 800 B. ordinary shares of 1s. each. Permanent directors: J. W. T. Cadett, C. Gilbert Moore, D. H. McNeile and A. Adkins. Registered office: 10, Heddon Street, Regent Street, W.1.

Personal.

THE LATE MR. W. FARRAR, of Farrar & Young, Limited, engineers, Leeds, left £12,225.

MR. J. WOOD has been elected a director of the Weardale Steel, Coal and Coke Company, Limited.

THE LATE MR. J. H. DEWHURST, chairman and managing director of Dewhursts' Engineering Company, Limited, left £19,585.

COLONEL C. COGHLAN, lately chairman of the Coghlan Steel & Iron Company, Limited, who died on October 14, left estate of the gross value of £61,659, with net personalty £60,493.

Gazette.

MESSRS. S. G. COZENS, R. Grose, and E. G. Coombs, electrical engineers and contractors, Ormonde House, 63, Queen Victoria Street, London, E.C., trading under the style of S. G. Cozens & Company, have dissolved partnership

THE PARTNERSHIP heretofore subsisting between Messrs. H. R. Wilson and J. W. Pattison, iron and steel merchants, 50, Grey Street, Newcastle-upon-Tyne, and at Sunderland, trading under the style of Haigh Wilson & Company, has been dissolved.

IRON AND STEEL MARKETS.

Pig-iron.

The process of deflation of pig-iron values from almost week-to-week may now be said to be about the only outstanding feature of note in market operations, the trade, as a whole, continuing lifeless, and very little stimulated by the tempting prospect of even cheaper metal in the near future. The most recent reduction reported is from Tees-side, where the Cleveland ironmasters last week decided upon a further cut of 10s. per ton in the agreed minimum selling prices, which must mean in present working conditions an additional loss to makers, whose profits by this time must have quite reached the vanishing point. It must also be remembered that even with this latest reduction Continental foundry pig can be landed in Scotland cheaper than Cleveland iron owing to the high transport charges, but an intimation of the railway companies in regard to freight rates which will be made known shortly suggests that if a reasonable reduction be made the revival of the Cleveland iron trade may be anticipated in the New Year. An expansion in the demand for Cleveland iron would certainly involve the lighting up of more furnaces, as only three are now producing this class of iron, but the four more furnaces to be lighted up on hematite should be more than ample to meet all present requirements Revised quotations now rule as follows :—No. 1 Cleveland foundry iron, 105s. ; No. 3 Cleveland G.M.B., 100s. ; No. 4 Cleveland foundry, 95s. ; No. 4 Cleveland forge, 90s. ; mottled and white, 87s. 6d. and 85s. Pig-iron shipments from the Port of Middlesbrough during November, up to and including the 29th ult., have amounted to 11,300 tons, as compared with 15,585 tons in the corresponding period of October. In the Midlands also values continue on the down grade, smelters being now ready to accept £4 12s. 6d. at furnaces for Derbyshire forge, and the same is probably true with regard to the quotation of £4 17s. 6d. for No. 3 foundry. Northamptonshire makers would be glad to find freer openings for the small amount of forge they have to sell at £4 10s. per ton. The price quoted for Northamptonshire foundry is £4 15s. Scotch pig-iron sells slowly, and, though the production is very limited, makers have considerable difficulty in disposing of outputs.

The East Coast hematite trade remains in a languid condition, and while, for purely technical reasons, four more furnaces are going into blast on this quality of iron, makers have still much difficulty in disposing of output. Some occasional parcels are, however, sold for shipment, the current price, nominal, being 110s. for mixed numbers.

Finished Iron.

Business in all departments of the finished iron industry remains disappointing in the extreme, and, notwithstanding the recent drastic reductions in prices of some of the leading lines, buyers resolutely abstain from entertaining offers except for the most urgent requirements. In the circumstances, bar mills are only running intermittently, and even the more favoured makers of marked qualities are by no means working at anything like capacity. This fact is, perhaps, the more remarkable when it is remembered that only some twelve months back marked bars were selling at about double their present price of £16 per ton. The demand for the lower quality material is slack, owing mainly to the prevailing idleness in the nut, bolt, chain and fencing industries throughout South Staffordshire. Second-class bars at £13, the new quotation, are declared by makers to be unprofitable, while on the other hand some unassociated firms are stated to be now offering as low as £12 15s. In Scotland, last week, the Bar Iron Association intimate that it is only the price of malleable crown bars which is reduced by 30s. The price of rivet, nut, bolt and spike iron is reduced by 10s., making the basis price for both crown bars and rivet, nut, bolt, and spike iron £12 10s. per ton.

Steel.

The recent setback in the outlook of the steel industry, following the cancellation of the Government warship contracts, has hardly as yet subsided, conditions, if anything, tending to further depression with little prospect of recovery until the turn of the year, and then only by a revival of world demand for material, which at present seems exceedingly remote. Sheffield especially has been hard hit by the disappointment, the orders for ship and armour plates alone for the four Navy vessels running into many thousands of pounds during the anticipated completion of the contracts. Market movements in steel products generally are at a standstill, the reductions in prices recently notified having had little effect in attracting new business, few fresh orders being booked except for immediate pressing contingencies. At present there are only about twenty-five per cent. of the furnaces turning out special steels employed, the chief output being confined to acid qualities. In semi-products, reports are current of soft-basic billets being offered at from £7 10s. to £7 15s. per ton. In the West of Scotland, steelmaking continues slowly to improve, and various departures in the working out of material are projected. In black sheets, which have been long run from imported Belgian billets, efforts are directed to making billets here, though special rolling plant has to be laid down.

Scrap.

Demand for this class of material everywhere continues quiet, reports from the Midlands, however, marking some slight improvement in certain classes of scrap, though cast-iron qualities are still very weak, and buyers are few and far between. Sellers are asking £4 10s. per ton f.o.r. for heavy cast-iron scrap, but the founders' idea of price is some 5s. to 10s. per ton below this. A few parcels of light cast-iron scrap have changed hands at prices from £3 to £3 10s. per ton. There is only a small demand for wrought-iron scrap for the forges. The prices to-day are, for piling scrap, £3 15s. delivered, and balling scrap, £3 delivered. In South Wales the scrap market continues quiet, with prices as follows :—Heavy steel scrap in furnace sizes, 65s. to 70s. ; bundled steel scrap and shearings, 50s. to 62s. 6d. ; steel turnings, 52s. 6d. to 57s. 6d. ; mixed wrought-iron and steel scrap, 32s. 6d. to 62s. 6d. ; heavy cast-iron large pieces, 65s to 100s. ; good machinery scrap, £5.

Tinplates.

The tone of the tinplate market continues consistently steady, with prices showing a corresponding tendency. Quotations rule about 21s. 3d. to 21s. 6d. basis for coke qualities, net cash, f.o.b. for January-February, with 21s. 6d. paid for December. Wasters are in steady request. CW 28 x 20 rule firm at 41s. per box for spot delivery. CW 14 x 20 are steady at round 20s., but CW 14 x 18¾ are a little easier at 19s., all net, f.o.t. at works. Terneplates are meeting with a little more inquiry, a moderate business being reported at round 20s. 6d. basis, net, f.o.b.

Metals.

Copper.—The improvement in the copper position in the States has been reflected in the market this side, and although demand of home consumers is only moderate, holders of the metal continue reserved in offerings. At this week's opening values showed a hardening tendency, with December sales marked £67 5s. to £67 10s., closing with a slight improvement, both cash and forward. Refined copper was unchanged, electrolytic closing at £75, and wire bars at £76 5s. Closing prices :—Cash : Wednesday, £67 ; Thursday, £67 2s. 6d. ; Friday, £67 ; Monday, £67 2s. 6d. ; Tuesday, £67 5s. Three months : Wednesday, £68 ; Thursday, £68 ; Friday, £67 17s. 6d. ; Monday, £68 ; Tuesday, £68 2s. 6d.

Tin.—Eastern advices over the week-end giving sales at Singapore at £168 c.i.f., an advance of 30s. on the previous quotation, gave a firmer tone to the opening of the market over here, January being done at £167, and with strong buying on account of Dutch interests influenced a further advance on both cash and forward deliveries. December was done at £166 15s. to £167 5s. ; January, £167 to £167 10s. ; February, £168 to £168 10s. ; March, £169 to £168 10s. English ingots also closed higher at £166 10s. Stocks of tin in London warehouses decreased 68 tons on the week at 5,528 tons ; Liverpool total was increased to 2,315 tons, and Swansea unchanged at 10 tons. Closing prices :—Cash : Wednesday, £162 10s. ; Thursday, £163 5s. ; Friday, £164 12s. 6d. ; Monday, £167 ; Tuesday, £167 17s. 6d. Three Months : Wednesday, £164 10s. ; Thursday, £165 2s. 6d. ; Friday, £166 5s. ; Monday, £168 15s. ; Tuesday, £169 10s.

Spelter.—The week's markets for this metal disclose a fairly active inquiry, and supplies are more difficult to negotiate, Norway and Germany offering very sparingly, whilst Belgian sellers' prices are above London parity. Indian brands of hard spelter are firmly held in view of potential domestic demands. Closing prices :—Wednesday, £26 15s. ; Thursday, £26 17s. 6d. ; Friday, £26 10s. ; Monday, £26 10s. ; Tuesday, £26 10s.

Lead.—The market for lead shows a somewhat quieter tendency, and only a small turnover is reported. Prices for soft foreign pig, on the whole, remain steady, with some irregularity towards the close. English closing prices :—Wednesday, £27 ; Thursday, £27 ; Friday, £26 10s. ; Monday, £26 10s. ; Tuesday, £26 10s.

XUM

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d
Standard cash	67	5	0
Three months	68	2	6
Electrolytic	75	0	0
Tough	67	12	6
Best selected	68	0	0
Sheets	101	0	0
India	94	0	0
Wire bars	76	10	0
Do. Jan.	76	10	0
Do. Feb.	76	10	0
Ingot bars	76	0	0
H.C. wire rods	82	0	0
Off. aver. cash, Nov. 66	13	6	3/11
Do. 3 mths., Nov. 67	9	9	3/11
Do. Settlement Nov. 66	12	7	11/11
Do. Electro, Nov. 75	6	9	9/11
Do. B.S., Nov. 68	6	1	1/2
Aver. spot, copper, Nov.	66	12	6 1/2
Do. Electro, Nov. 76	5	11	
Solid drawn tubes			14 1/2d.
Brazed tubes			14 1/2d.
Wire			11d.
Yellow metal rods			7 1/2d.
Do. 4x4 Squares			9d.
Do. 4x3 Sheets			9d

BRASS.

Solid drawn tubes	12 1/2d.
Brazed tubes	14 1/2d.
Rods	11 1/2d.
Sheets to 10 w.g.	11 1/2d.
Wire	11 1/2d.
Rolled metal	10 1/2d.

TIN.

	£	s.	d
Standard cash	167	17	6
Three Months	169	10	0
English	167	0	0
Bars	169	0	0
Chinese	165	0	0
Straits	167	10	0
Australian	167	5	0
Eastern	166	15	0
Banca	167	5	0
Off. aver., cash, Nov. 159	0	2	3/23
Do. 3 mths., Nov. 160	19	5	13/23
Do. Sttlment. Nov. 158	18	6	3/11
Aver. spot, Nov.	158	18	5

SPELTER.

	£	s.	d
Ordinary	26	10	0
Remelted	24	0	0
Hard	17	15	0
Electro 99.9	29	10	0
English	nominal		
India	21	10	0
Prime Western	27	10	0
Zinc dust	45	0	0
Zinc ashes	5	0	0
Off. aver., Nov.	26	4	10 7/11
Aver., spot, Nov.	25	18	6 1/2

LEAD.

	£	s.	d
Soft foreign ppt	25	17	6
English	26	10	0
Off. average, Nov.	24	4	10 7/11
Average spot, Nov	24	9	8

ZINC SHEETS.

	£	s.	d
Zinc sheets, spot	35	0	0
Do. V.M. ex. whf.	35	0	0
Do. ppt., t.o.b., N.Y.			—
Dutch	34	0	0
Boiler plates	32	10	0
Battery plates	32	0	0

ANTIMONY.

	£	s.	d
English regulus	35	10	0
Special brands	37	0	0
Chinese	24	10	0
Crude	17	0	0

QUICKSILVER.

	£	s.	d
Quicksilver	10	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d
Ferro-silicon—			
45/50%	11	15	0
75%	19	0	0
Ferro-vanadium— 35/40%	20/6 lb. va.		
Ferro-molybdenum— 70/80%	6/6 lb. mo.		
Ferro-titanium— 23/25%, carbonless	1/3 lb.		
Ferro-phosphorus, 20/23%, £20			
Ferro-tungsten— 80/85%, carbon free	1/5 lb.		
Tungsten metal powder— 98/99%	1/8 lb.		
Ferro-chrome—			
4/6% car.	£26	0	
6/8% car.	£25	0	
8/10% car.	£24	0	
Ferro-chrome—			
Max. 2% car.	£76		
Max. 1% car.	£92		
Max. 0.75% car.	£108		
68/72%, carbonless	2/1½ lb.		
Nickel—99·8%, cubes or pellets	£190		
Cobalt metal—97%	14/- lb.		
Aluminium—98/99%	£120		
Metallic Chromium— 98/99%	5/3 lb.		
Ferro-manganese—			
76/80%, loose	£15		
76/80%, packed	£16		
76/80%, export	£14	10	
Metallic manganese— 98/99%, carbonless	2/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	8
Finished bars, 18% tungsten	3	

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Flats under 1 in. by ⅛ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness	3d. lb.
Bevels of approved sizes and sections	6d. lb.
If in coils	3d. lb.
Packing	5s. cwt
Bars cut to length	10% extra

Scrap from high-speed tool steel—

Scrap pieces	5d.
Turnings and swarf	2d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—£	s.	d.	£	s.	d.
Heavy Steel	3	5	0	3	10 6
Bundled steel & shearings			2	10	0
Mixed iron & steel	1	12	6	3	2 6
Heavy cast iron				3	5 0
Good machinery for foundries				5	0 0
Cleveland—					
Heavy steel				2	17 6
Steel turnings				2	0 0
Cast-iron borings				1	19 0
Heavy wrought iron piling				4	0
Bundling scrap				2	17 6
Cast-iron scrap				4	7 6
Lancashire—					
Cast iron scrap				5	0 0
Heavy wrought				3	7 6
Steel turnings				2	5 0
London—			£	s.	d.
Copper (clean)			50	0	0
Brass (clean)			26	0	0
Lead (less usual draft)			22	0	0
Tea lead			20	0	0
Zinc			13	0	0
New aluminium cuttings			60	0	0
Braziery copper			40	0	0
Gun metal			38	0	0
Hollow pewter			115	0	0
Shaped black pewter			75	0	0

GANISTER.

Plastic	25/-
Dry	20/-

PIG-IRON.

N. E. Coast—	
Foundry No. 1	105/-
Foundry No. 3	100/-
Forge No. 4	90/-
Mottled	87/6
Hematite No. 1	112/6
Hematite M/Nos.	110/-
Midlands—	
Staffs. common	145/-
„ part-mine forge	160/-
„ „ foundry	180/-
„ Cold blast	300/-
„ basic	—
Northants forge	90/-
„ foundry No. 3	95/-
„ basic	—
Derbyshire forge	92/6
„ foundry No. 3	97/6
„ basic	—
Scotland—	
Foundry No. 1	125/-
„ No. 3	120/-
Hematite M/Nos.	130/0
Sheffield (d/d district)—	
Derby forge	—
„ foundry No. 3	—
„ basic	—
Lincs. forge	—
„ foundry No. 3	—
„ basic	—
E.C. hematite	123/-
W.C. hematite	135/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
„ foundry No. 3	—
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	145/9
Glengarnock foundry	150/9
Gartaherrie foundry	145/9
Monkland foundry	145/9

FINISHED IRON & STEEL.

Iron—	£	s.	d.
Bars (crown)	13	0	0
Angles	13	10	0
Tees to 3 united ins.	14	0	0
Nut and bolt	13	0	0
Hoops	16	10	0
Marked bars (Staffs.)	16	0	0
Gas strip	15	0	0
Bolts and nuts, ⅜ in. × 4 in.	23	0	0
Steel—			
Ship plates	10	10	0
Boiler plates	16	0	0
Chequer plates	11	10	0
Angles	10	0	0
Tees	11	0	0
Channels	10	5	0
Joists	10	10	0
Rounds, ½ in.–3-in.	12	0	0
Rounds, 3 in.–5½ in.	11	10	0
Flats, 5 in.–8 in.	13	0	0
Flats over 8 in.	13	0	0

	£	s.	d
Rails, heavy	10	10	0
Fishplates	17	10	0
Hoops	13	10	0
Black sheets, 24 g.	14	10	0
Galv. cor. sheets, 24 g.	17	15	0
Galv. fencing wire, 8 g. plain	17	10	0
Rivets, ¾ in. dia	17	10	0
Billets, soft	7	5	0
Billets, hard	8	5	0
Sheet and tin bars	7	15	0

PHOSPHOR BRONZE.

	Per lb basis.
Strip	1 5½
Sheet	1 5½
Wire	1 5½
Rods	1 4½
Tubes	1 7½
Castings	1 2

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/- to 1/6
Rolled—	
To 9 in. wide	1/7 to 2/1
To 12 in. wide	1/7½ to 2/1½
To 15 in. wide	1/8½ to 2/2½
To 18 in. wide	1/9½ to 2/3½
To 21 in. wide	1/10½ to 2/4½
To 24 in. wide	1/11½ to 2/5½
Ingots for spoons and forks	1/- to 1/6
Ingots rolled to spoon size	1/3 to 1/9
Wire round—	
3/0 to 10. G.	1/9½ to 2/4½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	22.84
No. 2 foundry Valley	20.50
No. 2 foundry, Birm.	18.00
Basic	21.96
Bessemer	21.96
Malleable	21.96
Grey forge	21.46
Ferro-manganese 80 % delivered	60.00
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	29.00
O.-h. billets	29.00
O.-h. sheet bars	30.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	1.95
Steel bars	1.50
Tank plates	1.50
Beams, etc.	1.50
Skelp, grooved steel	1.60
Skelp, sheared steel	1.60
Steel hoops	2.00
Sheets, black, No. 28	2.75
Sheets, galv., No. 28	3.75
Sheets, blue an'l'd, 9&10	2.25
Wire nails	2.75
Plain wire	2.50
Barbed wire, galv.	3.55
Tinplate, 100-lb. box	$4.75

COKE.

Welsh foundry	40/-	45/-
„ furnace	20/-	25/-
Durham & North. foundry		37/6
„ furnace	20/-	25/-
Other Districts, foundry		50/-
„ furnace		23/-